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METHOD OF MAKING THIN ABRASIVE WHEELS

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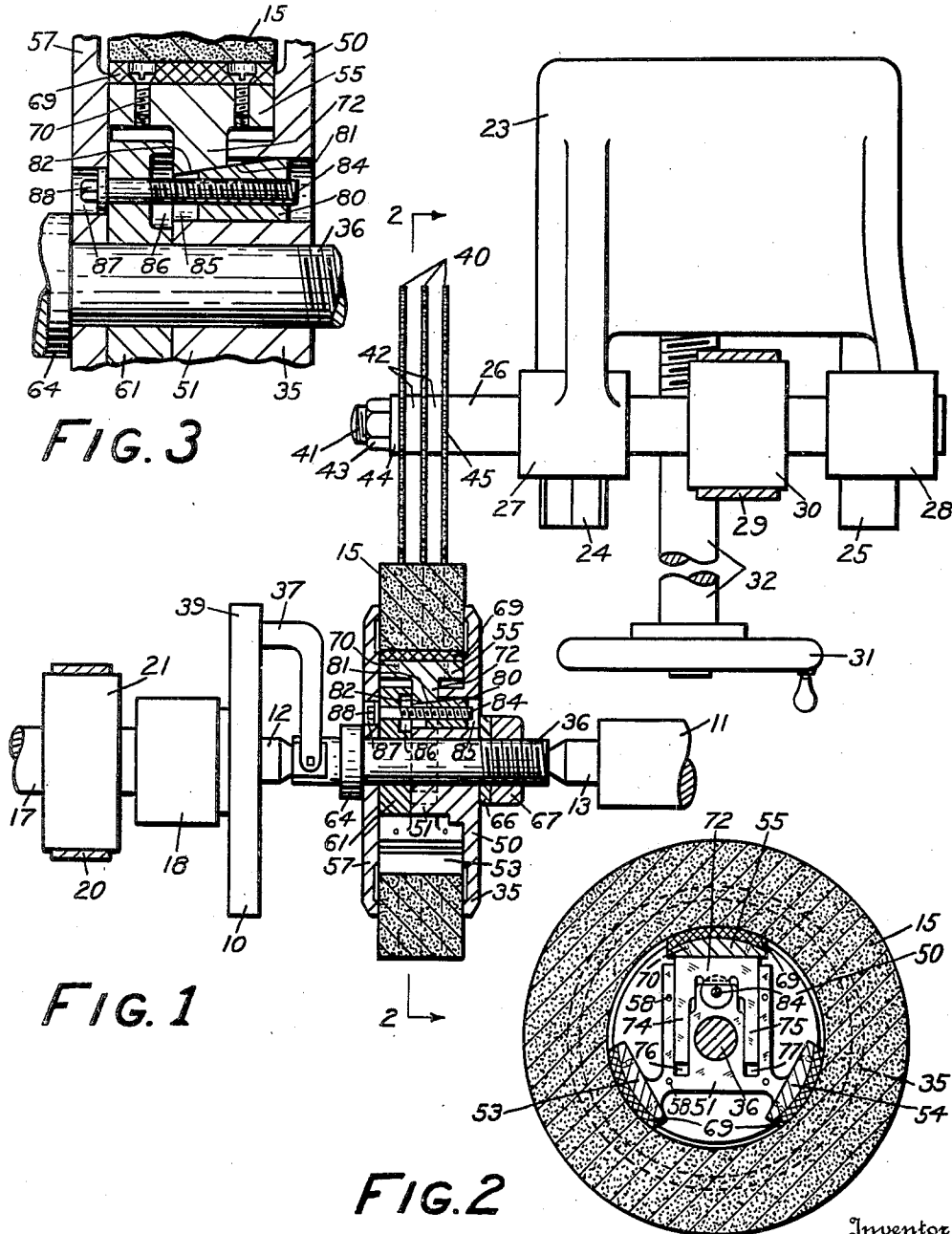


FIG. 3

FIG. 1

FIG. 2

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METHOD OF MAKING THIN ABRASIVE
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This invention relates to abrasive articles and more particularly to a method of making abrasive wheels of extreme thinness.

Heretofore, abrasive wheels used for screw thread grinding and edge grinding of sheet glass have been made of large diameter and thin cross-section, the largest being 30 inches in diameter, and they vary from one-eighth inch to one-half inch in thickness. These wheels are ordinarily made of a mixture of abrasive grains of the proper grit size bonded by a vitrified ceramic material. The common method of making such vitrified wheels is to mix with the granular abrasive material, a mixture of vitrifiable ceramic materials, mould the mixture into the desired form and then fire the mass in a kiln to approximately 1300° C. to fuse or vitrify the bonding material, which serves to cementitiously bond the mixture into a solid mass of great mechanical strength. Before firing, the raw wheel mixture is extraordinarily fragile and lacks sufficient "green" strength to hold the materials together. For this reason, there has been considerable loss in manufacturing through breakage in the handling of the wheels which they are ordinarily subjected to preparatory to the firing treatment. Hence, it is found that the extreme fragility of the composition of the "green" mix imposes a practical limit on the thinness of the product.

In order to eliminate these losses and to secure sufficient mechanical strength of the "green" mix, it has been the practice, heretofore, to mould the thin raw wheels, such as a half inch wheel, to a thickness of 1½" and greater, so that they may be handled safely during manufacture and to permit them to be transported into the kiln. After firing, the excess material is trimmed or "faced off" so as to make a wheel of the proper thickness. This method, however, has proved slow, laborious and extremely wasteful in material and has involved further expense to the wheel makers in reclaiming the abrasive material, in addition to the high manufacturing expense arising from the prior laborious and costly procedure.

It is therefore the object of my invention to eliminate this wasteful procedure and to provide a new, simple and economical method of making such thin vitrified abrasive articles of ceramic bonded abrasive material in varying diameters and sizes which are too thin in cross-section to be readily manufactured by the standard moulding and firing operations.

Further objects will be apparent in the following disclosure to one skilled in the art, and the nature and scope of this invention will be pointed

out and specifically covered by the claims appended hereto.

In the drawing, in which I have shown one specific embodiment of my invention:

Fig. 1 is a diagrammatic view, partly in section, illustrating one form of apparatus by which the herein described method may be practiced.

Fig. 2 is a section on the line 2—2 of Fig. 1, showing an end view of the mechanism for supporting and holding the abrasive body to be sliced; and

Fig. 3 is an enlarged sectional view, showing in detail the mechanism for actuating the movable clamping block.

In accordance with this invention I propose to make thin vitrified grinding wheels which the grinding art now demands, in varying diameters and sizes, and which are too thin to be readily manufactured by standard moulding and firing operations by first moulding a thick body of granular abrasive material, such as an abrasive cylinder, bonded by a ceramic bond in the raw state, in compliance with the accepted manufacturing practice. In carrying out this procedure, it is desirable that the thickness of this initial abrasive body be made sufficient for moulding and bonding operations and greater than that of a multiple of the thickness of the desired product, due consideration being given to the firing and drying shrinkages. The moulded body, while in the "green" condition, is then fired in a kiln, in accordance with standard practice, to a temperature of approximately 1300° C. to fuse or vitrify the bonding material. After vitrification, the hard glassy body is removed from the kiln and cut into a multiplicity of thin laminæ or disc-like sections of substantially the desired dimensions and thickness which constitute and form a plurality of complete abrasive wheels when detached and severed from the abrasive body.

To accomplish this cutting operation, I propose to mount the abrasive body in a juxtaposed position with respect to one or more rapidly rotated and positively driven cutting tools, such as one or more grinding wheels, and with the body so presented thereto and slowly rotating said body to be cut about its own axis, to relatively feed said tool or tools and said body toward each other at a uniform rate, while relatively rotating them simultaneously with said feeding movement, to cause said cutting tool or tools to cut laterally through the abrasive body and cut off thin annular sections or laminæ therefrom. When detached, these sections may

be afterwards subjected to a subsequent finishing operation, if desired, to remove any coarse tool markings which may have been left on their sliced faces during the cutting operation. There are several feasible ways by which this finishing treatment may be performed, for example, a diamond or other standard truing tool may be applied to the surface to be treated and so shave off the material.

In general, however, it is found that in carrying out the ordinary cutting-off operation, the surfaces of the product wheels have a satisfactory finish and do not require any further treatment, and that each wheel may be cut accurately to the required thickness. Hence, in manufacturing such wheels, it is merely necessary that the larger abrasive body to be split have its thickness equal to the sum of the widths of the product wheels plus the width of the cut or cuts produced by the cutting-off grinding wheels. In this way, if the thick wheel to be split is of the required diameter and is provided with finished sides, before the cutting operation, then the product wheels subsequently produced will require no further finishing treatment, either as to size or as to the condition of the cut surface.

While my method may be carried out by means of various forms of apparatus, I have shown in the drawing one simple form of cutting-off machine which is adapted for the purpose, and which comprises the work rotating and wheel feeding mechanisms of a grinding machine of the type shown in the patent to Norton No. 762,838 dated June 14, 1904. As illustrated, the machine comprises a head stock 10 and a tailstock 11 which are equipped with the usual work centers 12 and 13, respectively, for supporting the abrasive body for rotation during the slicing operation. The headstock 10 is provided with a driving spindle 17 which is journaled in a bearing 18 of suitable construction. The spindle 17 may be driven by a belt 20 and a pulley 21 which may be connected with any suitable source of power. A wheel carriage 23, mounted on the usual ways 24 and 25 for sliding movement transversely to the axis of the work centers, is provided on which is mounted a rotatable grinding wheel spindle 26. This spindle is journaled in suitable bearing members 27 and 28 on the carriage 23 and it is arranged to be driven by a belt 29 and a pulley 30 from any suitable source of power. A hand wheel 31 and a feed screw 32 are connected to the wheel carriage 23 by suitable mechanism, not shown, to move the carriage in a crosswise direction toward and from the axis of the work centers.

The abrasive body 15 to be cut, which preferably comprises an abrasive cylinder, is mounted in a chuck 35 which is constructed to hold the body rigidly and securely during the cutting operation. The chuck 35 is fastened to an arbor 36 which passes therethrough and is arranged to be supported upon and between the centers 12 and 13. A driving dog 37 is provided, which is clamped to the headstock end of the arbor 36 and has its free end portion in interlocking engagement with a rotatable driving plate 39 carried by the headstock spindle 17.

The cylinder 15 comprises a wide, thick, annular abrasive body composed of a mixture of granular abrasive material, such as silicon carbide or crystalline alumina, bonded by a suitable ceramic bonding material in the raw state. The ingredients are intimately mixed together and the resultant mixture then moulded to the desired shape and thereafter converted by fusion or

vitrification to a vitrified condition, in accordance with standard practice. It is desirable that the cylinder be of predetermined dimensions and have substantially the same diameter as and a thickness greater than that of a plurality of product wheels in order to make due allowance for the material wasted during the cutting process. In practice, these cylinders vary from 10 inches to 30 inches in diameter, and the width of their peripheral faces is seldom greater than one foot across.

To cut a plurality of thin annular sections of predetermined thickness quickly and easily from the cylinder 15 in a single operation I may employ a series or gang of grinding wheels 40 which are mounted in spaced relationship upon the common wheel spindle 26. These grinding wheels 40 may comprise the standard cutting-off wheels, such as are well known in the art for cutting metal rods and bars, and which ordinarily comprise thin grinding discs composed of abrasive grains bonded by an organic bond, such as shellac, rubber or a synthetic resinoid material. As illustrated in the drawing, the wheels 40 are shown as being mounted on the reduced end portion 41 of the wheel spindle 26, and they are held thereon in spaced relationship to each other by the collars 42. These collars have substantially the same diameter and their thickness is of such predetermined values as to precisely position and space the wheels 40 so that the spacing therebetween is precisely regulated so that annular sections of a predetermined thickness are obtained from the cylinder 15 when they are applied thereto. A nut 43 and a washer 44 serves to secure the wheels 40 on the portion 41 and to clamp them tightly thereon against the shoulder 45 joining the body of the spindle 26.

In order that the cylinder 15 may be fixedly supported for rotation with the chuck 35 during the cutting operation, as illustrated in the drawing, the chuck 35 comprises a circular plate 50 having a hub portion 51 projecting outwardly from a side face thereof, which is provided with a suitable bore for mounting the plate on the arbor 36. The hub 51 may be of any geometrical shape but it is shown in the drawing as being rectangular. Depending from the bottom corners of the hub 51 and formed integrally therewith are fixed clamping blocks 53 and 54, respectively, as shown in Fig. 2, the outer periphery of each having a convex cylindrical surface which is arranged to fit against the inner concave surface of the bore of the cylinder 15. Mounted on the hub 51 and radially opposed to the fixed blocks 53 and 54 is a movable, expandable, clamping block 55 which is substantially of the same size and shape as the fixed blocks and has its peripheral face correspondingly curved. The blocks 53, 54 and 55 are arranged about the hub 51 so that their angular and radial dimensions are substantially equal in order that they may form a segmental support for the abrasive body 15, the curved surfaces of the blocks lying inside of and defining the outer periphery of an imaginary cylinder representing a supporting drum.

The abrasive body 15 to be cut, which is so arranged in the chuck as to present its outer peripheral face to the cutting wheels 40, is set over the blocks 53, 54 and 55 after which the block 55 is tightened against the inner periphery of the body so as to draw it up tightly against the fixed blocks 53 and 54 and to hold it securely in the position shown in Fig. 2 of the drawing.

To the outer end face of the body 15 is clamped a circular plate 57 which is arranged to be fastened to the plate 50 by suitable bolts screw threaded into apertures 58 located in the hub 51.

5 Interposed between the plate 57 and the end of the hub 51 is a spacing member 61 which serves to prevent the plates 50 and 57 from being clamped too tightly against the side faces of the body 15 when the bolts are turned down.

10 To mount the chuck 35, which carries the body 15 to be cut, upon the arbor 36 and to permit it to be rotated during the cutting operation, the plates 50 and 57 of the chuck 35 are provided with central openings having a sliding fit with
15 the arbor, so that when mounted thereon, the chuck is slidable longitudinally therealong so that it may be positioned against a fixed collar 64 carried by the arbor 36 and held thereagainst by the clamping pressure which is applied to the
20 outer face of the plate 50 by a washer 66 and nut 67 suitably screw threaded on the arbor 36.

In order that the inner peripheral surface of the cylindrical body 15 may be tightly gripped by the clamping blocks, due to the expansion of
25 the block 55, and to provide a means for receiving the radial thrust of the cutting wheels as they are fed inwardly toward the arbor 36 in order to cut through the rim of the cylinder, the outer peripheral face of each of the clamping blocks 53,
30 54 and 55, respectively, is provided with a facing 69 of resilient and yieldable material, such as leather, which is fastened thereto by suitable screws 70.

The block 55 is mounted for radial movement in and out of the hub 51 and for lateral movement across the face of the plate 50 by an arm
35 72 which depends from the bottom surface of the block. The end portions of the arm 72 are shown as being of bifurcated shape in order to form a pair of depending leg members 74 and 75 which
40 are arranged for sliding movement within suitable guideways 76 and 77 formed in the end of the hub 51.

In order that the block 55 may be expanded and so moved outwardly and laterally across the face of the plate 50 to hold the cylinder 15 tightly on the chuck, a movable wedge member 80 is provided which is partially cylindrical in shape, the top portion of which comprises a flat inclined
50 surface 81 which is arranged to engage a complementary flat and inclined surface 82 formed on the end of the arm 72. The wedge 80 is adjustably positioned in the hub 51 by a bolt 84 and it is arranged for sliding movement in a
55 cylindrical aperture 85 formed therein which extends therethrough in a direction parallel to its axis. The bolt 84 is loosely mounted in the spacing member 61 and it is centrally disposed in a cylindrical cavity 86 located therein which is
60 formed in the end face of the spacer immediately abutting the hub 51, the cavity 86 being axially aligned with the aperture 85 whereby it may serve to accommodate the end of the member 80 when it is moved to the extreme left position, as
65 viewed in Fig. 1. A suitable aperture 87 formed in the plate 57 is arranged to receive the head portion 88 of the bolt 84 and so provides a means of easy access thereto whereby the bolt may be turned to move the wedge 80 and thereby expandingly move the block 55 into firm contact
70 against the inner face of the cylinder.

In accordance with this invention, I may produce a series of vitrified bonded abrasive wheels of extreme thinness directly to the desired thickness thereby greatly reducing the time hereto-

fore required to manufacture the wheels. Furthermore, the improved process is easier to control and has to a large extent eliminated the great waste of "green" material heretofore resulting from the prior method of making these
80 thin articles. While the invention is particularly applicable to the manufacture of vitrified wheels, it may also be employed to make grinding wheels having other types of bonds and the claims are to be interpreted accordingly.

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

1. The method of making thin grinding wheels comprising the steps of first making a thick annular abrasive body of vitrified ceramic bonded
90 abrasive grains which has substantially the same diameter as and a thickness greater than that of a plurality of the product wheels and then supporting and rotating said abrasive body slowly about its axis and simultaneously cutting it laterally with a set of thin precisely spaced positively rotated abrasive wheels to form a multiplicity of thin annular sections which when severed constitute complete grinding wheels of the
95 desired finished dimensions.

2. The method of making thin grinding wheels comprising the steps of first making a thick body of said bonded abrasive grains which has substantially the same diameter as and a thickness
105 greater than that of a plurality of the product wheels, then feeding a rapidly rotated thin grinding wheel into said body and cutting it into a multiplicity of laminae of substantially the desired thickness while slowly rotating said abrasive body to be cut about its axis, and thereafter finishing the faces of the laminae and forming grinding wheels thereof.

3. The method of making abrasive wheels comprising the steps of supporting a cylindrical abrasive body composed of abrasive grains bonded by a vitrified bonding material such as to place the outer peripheral surface of said body in a juxtaposed position with respect to a gang of cutting tools, feeding said cutting tools and said abrasive
115 body relatively toward each other at a uniform rate, and positively rotating said cutting tools at high speed and said abrasive body slowly and simultaneously with said feeding movement to effect engagement between said cutting tools and
120 said abrasive body at different spaced positions to cut thin annular sections from said abrasive body which constitute a plurality of complete abrasive wheels.

4. The method of making thin abrasive wheels
130 comprising the steps of preforming a fired abrasive annulus of abrasive grains united by a vitrified ceramic bond, supporting the annulus upon its inner peripheral face on a rotatable support, holding the annulus tightly in such position by
135 providing radial gripping contact between said support and the inner peripheral face of the annulus, and thereafter simultaneously rotating said annulus slowly and cutting through it laterally by a positively driven and rapidly rotated
140 thin abrasive wheel to form thin annular sections of a predetermined thickness which when severed from the annulus constitute complete abrasive wheels of substantially the desired dimensions and thickness.

5. The method of making two or more grinding wheels comprising the steps of bonding abrasive grains into an integral cylindrical body having substantially the required diameter of the finished wheels and a thickness equal to the
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sums of the width of the product wheels and of each cut therebetween and thereafter rotating the abrasive body slowly about its axis while feeding a plurality of positively driven and rapidly
5 rotated thin abrasive cutting-off wheels radially into said body and cutting through it to form a plurality of abrasive wheels of the required dimensions and simultaneously providing the side surfaces of the product wheels with finished
10 ground surfaces, whereby grinding wheels of the final required thicknesses and surface appearance are produced.

6. The method of making two or more grinding wheels composed of abrasive grains bonded by
15 vitrified ceramic materials which are too thin to be readily manufactured by standard molding and firing operations comprising the steps of molding a body of abrasive grains and a ceramic bond in the raw state, firing the body to vitrify
20 the bond and producing a thick wheel having substantially the required diameter of the finished wheels and a thickness equal to the sums of the width of the product wheels and of each cut therebetween, and thereafter rotating the
25 body slowly about its axis while feeding a positively driven and rapidly rotated thin abrasive cutting-off wheel radially into said body and cutting it into a plurality of abrasive wheels of the

required dimensions and simultaneously providing the product wheels with finished ground surfaces, whereby grinding wheels of the final required thickness and surface appearance are produced.

7. The method of accurately producing a grinding wheel of a desired predetermined thickness which consists in positioning a plurality of positively driven cutting-off abrasive wheels relative to the peripheral face of a preformed abrasive cylinder so that they operate in a line at right angles to the axis of rotation of said cylinder, forcing said cutting-off abrasive wheels into the peripheral face of the cylinder while positively rotating the cylinder slowly and at a constant
85 speed and while simultaneously and positively rotating the cutting-off abrasive wheels constantly at high speed, and simultaneously causing a relatively lateral feeding movement between the cutting-off wheels and the abrasive
90 cylinder in a radial plane of the cylinder and in the direction of the axis of the latter in order to cut through the cylinder by grinding the abrasive particles and bond holding said particles
95 and form a plurality of thin annular sections which constitute complete grinding wheels having a selected thickness of cross section.

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