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Bosma et al.

[11] 3,795,077

[45] Mar. 5, 1974

[54] SEGMENTAL CUT-OFF GRINDING WHEEL

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[73] Assignee: **Norton Company**, Worcester, Mass.

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[52] **U.S. Cl.** **51/206.5**

[51] **Int. Cl.** **B24d 5/06**, B24d 5/08

[58] **Field of Search** ..... 51/206 NF, 206.4, 206.5

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Primary Examiner—Othell M. Simpson
Assistant Examiner—Marc R. Davidson
Attorney, Agent, or Firm—Walter Fred

[57] **ABSTRACT**

A high speed segmental cut-off grinding wheel has a reusable drive center with either one or a plurality of angularly spaced narrow segment aligning grooves of predetermined radial depth in its circumferential surface and a plurality of identical interchangeable, replaceable and detachable composite abrasive segments equally spaced around the center. Each abrasive segment has a segment support member, including resilient members extending into the aligning groove, engaging the center, and displacing the segment radially outward into a precise position and engagement with a plurality of quickly and easily removable segment locating and retaining members, each with a locking groove therein, inserted into axially aligned mating apertures in the center and extending through non-aligned locating apertures in the displaced segment support member. Sufficiently displacing each abrasive segment inwardly relative to the center deflects and preloads the resilient members and aligns the previously non-aligned locating apertures with the axially aligned apertures in the center for either inserting or removing the locating and retaining member to replace a segment. The resilient members bias the released composite abrasive segment outwardly with sufficient force to maintain the segment support member engaged with precision locating surfaces within the locking grooves of the locating and retaining members and thereby prevent axial displacement of the segment locating and retaining members.

17 Claims, 9 Drawing Figures

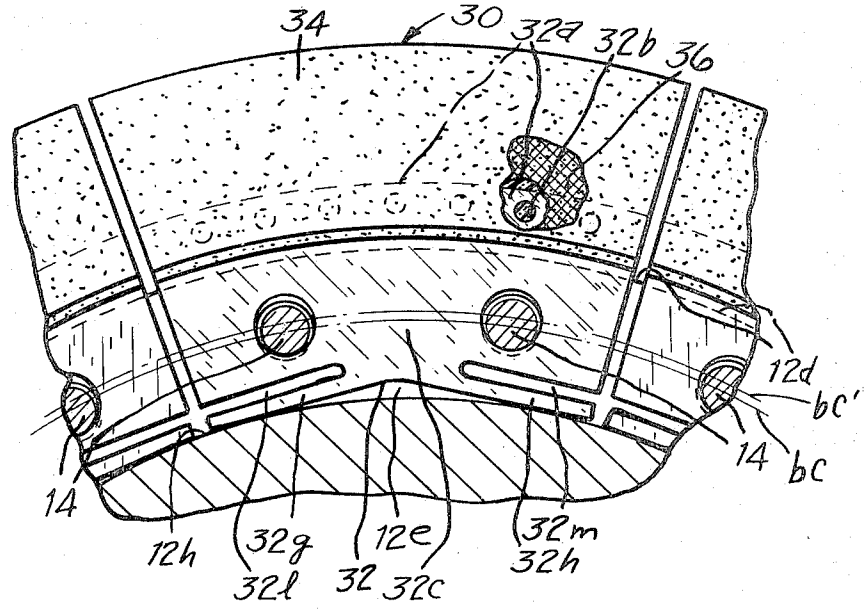


FIG. 1

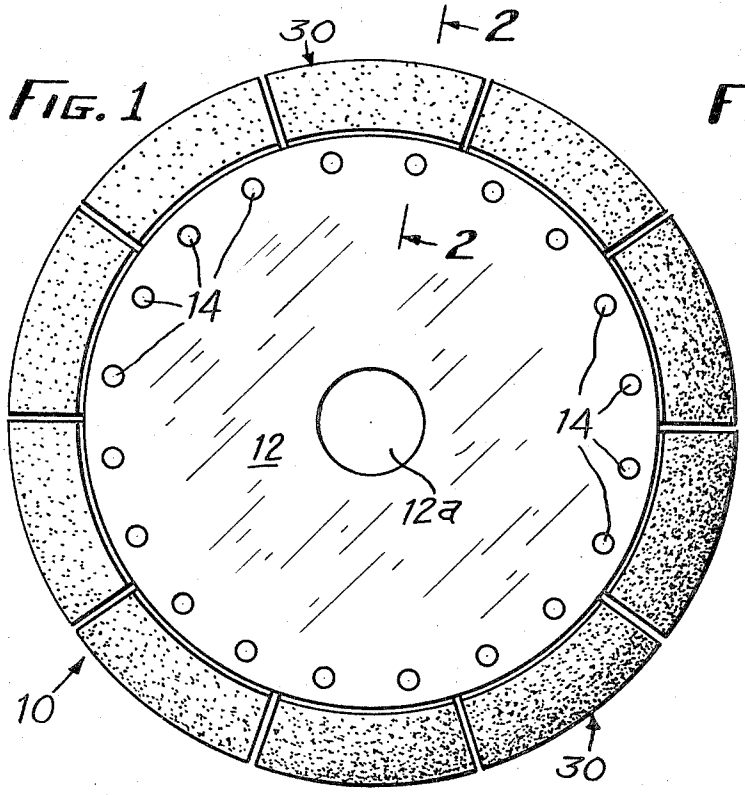


FIG. 2

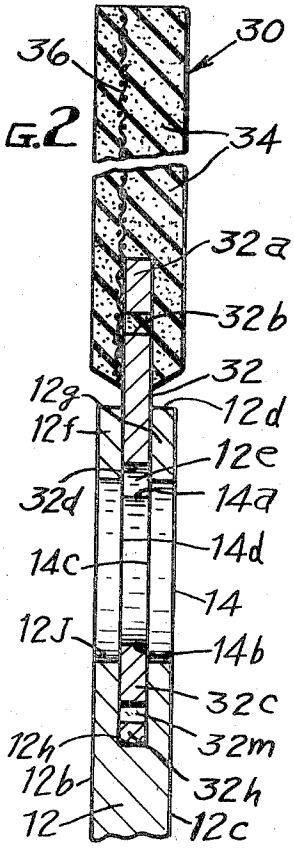
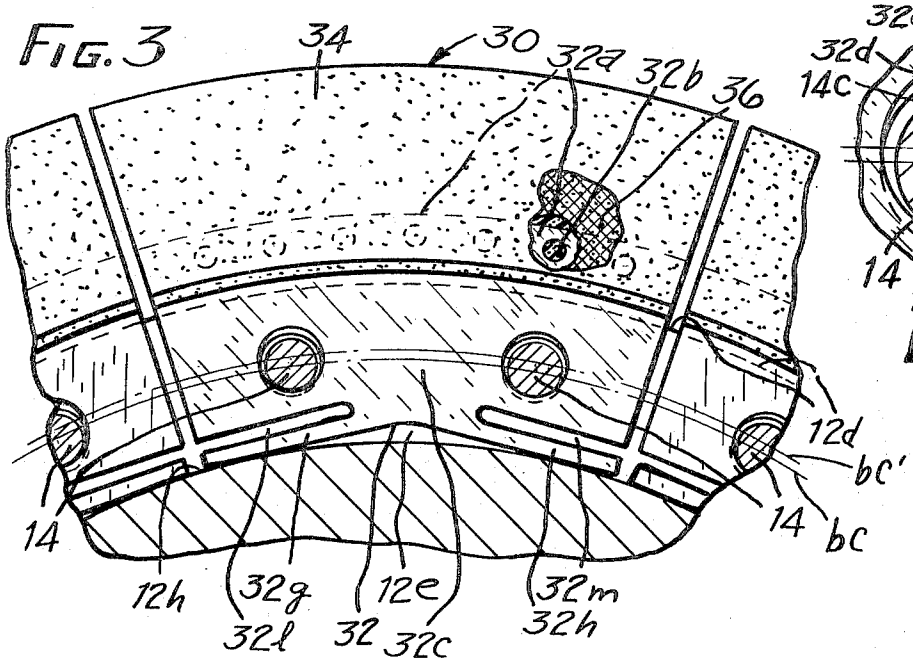


FIG. 3



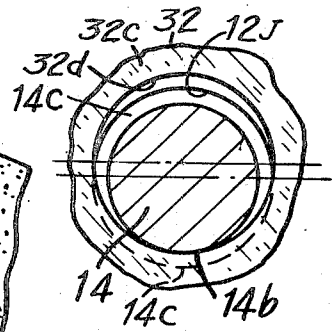


FIG. 4

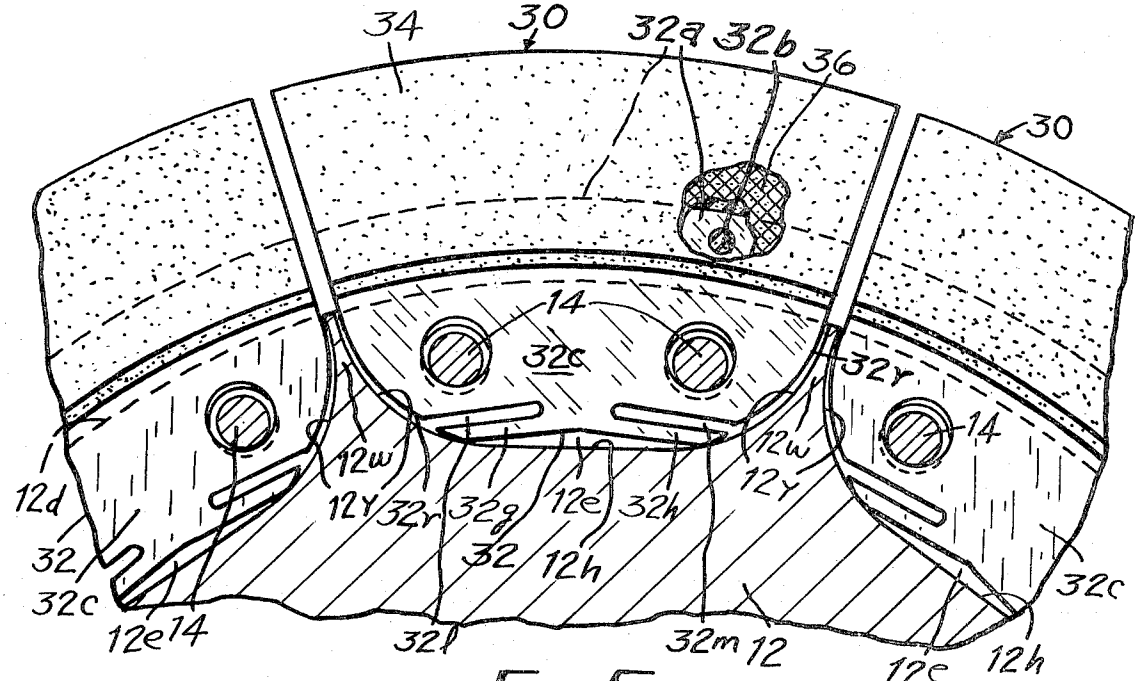


FIG. 5

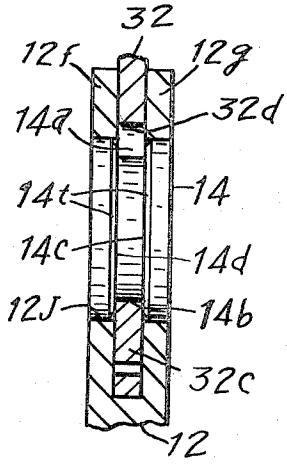


FIG. 6

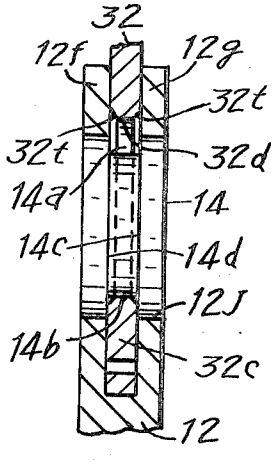


FIG. 7

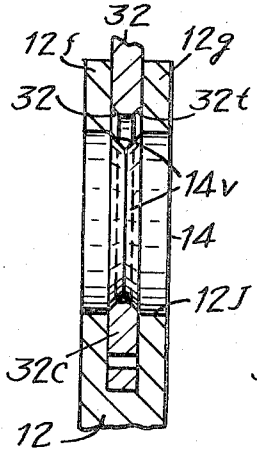


FIG. 8

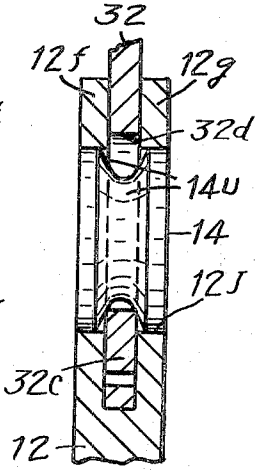


FIG. 9

SEGMENTAL CUT-OFF GRINDING WHEEL

BACKGROUND OF THE INVENTION

1. Field of Invention

The invention relates to relatively large high speed segmental cut-off grinding wheels with unique means for attaching and detaching a plurality of identical easily and quickly detachable, and interchangeable composite abrasive segments thereon.

2. Description of the Prior Art

Heretofore, abrasive segments have been attached to relatively small diameter and seldom reused drive hubs or centers by riveting, bolting, brazing and adhesively bonding them to the center. Thus, a great deal of time and effort is required to replace worn out segments with new ones. The applicants' segmental cut-off wheel differs from the prior art in that the abrasive segments can be replaced quickly, and are continually biased outwardly, by preload resilient members into a precise position determined by engagement with a plurality of easily and quickly removable segment locating and retaining members locked to and unlocked from a reusable center by radially displacing the abrasive segment and its support member situated within a peripheral groove in the center respectively into and out of a locking groove in the segment locating and retaining members.

Similar segmental cut-off grinding wheels are disclosed in copending applications of Joseph J. Paterno, Ser. No. 294,083 filed Oct. 2, 1972 and Loring Coes, Jr. Ser. No. 302,662 filed Nov. 1, 1972 and to which reference may be had for details not disclosed herein.

Also, in U.S. Pat. Nos. 237,472 issued to Blackburn, Feb. 8, 1881; 3,162,187 issued to Christenson, Dec. 22, 1964; 2,092,591 issued to Sohlstrom, Sept. 7, 1937; German Pat. Nos. 530,792 issued to Krug, July 23, 1931; and 1,652,883 issued to Berstecher on Mar. 11, 1971 there are disclosed various prior art grinding wheels of which the applicants are aware that are similar to but clearly distinguishable from the invention disclosed hereinbelow.

SUMMARY OF THE INVENTION

The invention relates to a high speed segmental cut-off grinding wheel of relatively large diameter with a thin reusable drive center or hub adapted with suitable means by which it can be mounted on an arbor and rotatably driven about an axis in the conventional manner. The thin drive center may have one or more narrow peripheral slots or grooves spaced circumferentially around the center and recessed radially inward from a peripheral surface extending between opposite sides of the center, a predetermined radial depth to a bottom surface, at the bottom of the groove, extending axially between opposed spaced flange portions of the center. There are a plurality of identical groups of axially aligned apertures of identical size and shape equally spaced around and extending axially through the opposed spaced flange portions with the axes of the apertures situated on a first base circle of predetermined radius from the axis of the center. A plurality of identical interchangeable, displaceable, replaceable, and detachable arcuate composite abrasive segments are equally spaced around and resiliently displaced radially outward relative to the center, each having, a thin segment base or support member with a perforated outer radial portion embedded in, interlocked with and

resin bonded to a thicker arcuate resin bonded abrasive portion or member and an inner radial portion or tongue portion projecting symmetrically therefrom into the groove between the opposed spaced flange portions of the center. The tongue portion has a plurality of identical segment locating apertures substantially identical in size, shape and spacing between their axes to the apertures in the flange portions and which have axes radially displaced to position situated and spaced on a second base circle of greater radius from the axis than the first mentioned base circle of predetermined radius when in the final grinding or cutting position. There are preloaded resilient means engaging the bottom surface and biasing the segments radially outward relative to the center into engagement with a plurality of segment locating and retaining members of identical size and shape extending axially through the non-aligned segment locating apertures in the thin segment base member into the axially aligned apertures in the spaced side flange portions of the center. Each segment locating and retaining member has intermediate its ends, a locking groove, including a segment locating surface therein, of predetermined depth and of substantially the same axial width as the groove between the flanges.

The composite abrasive segments are either removed from or attached to the center by forcing and displacing the composite segment radially inward toward the axis to further deflect or compress and preload the resilient means against the bottom surface until the segment locating aperture in the segment base member is aligned with the apertures in the flange portions after which the segment locating and retaining members are shifted axially sufficiently to remove and attach a segment to the center. A composite abrasive segment is locked to and precisely located relative to the center upon releasing the segment which allows the preloaded resilient means to bias the segment base member outwardly into the locking groove and engagement with the locating surface within the locking groove on the segment locating and retaining members which as a result are trapped or locked in place and prevented from being displaced axially by engagement with the segment base member engaging the center. The resilient means are preferably an integral part of a segment base member with inclined diverging inner surfaces of the tongue portion engaging the surface at the bottom of the groove. A slot extends a predetermined depth from each radial end of the tongue portion and adjacent to each of the diverging inner surfaces whereby a pair of deflectable elongated cantilever springs are provided for and resiliently engaging the bottom surface of the groove in the center.

Therefore, it is the primary object of the invention to provide a segmental cut-off grinding wheel having a thin reusable center including one or more peripheral segment aligning grooves into which extend support members of a plurality of identical interchangeable, replaceable and detachable reinforced composite abrasive segments continually forced radially outward, by resilient members, into locking engagement with segment locating and retaining members quickly unlocked and easily removed from the center by radially displacing the abrasive segments inwardly to attach and detach the abrasive segments to and from the center.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a view of an assembled segmental cut-off grinding wheel of the invention,

FIG. 2 is an enlarged cross sectional view taken on line 2—2 of FIG. 1, through one of the abrasive segments and a portion of the center to show how the abrasive segment is constructed and attached to the drive center,

FIG. 3 is a fragmentary cross sectional view through a side portion of one embodiment of the cut-off grinding wheel of the invention showing a side of one embodiment of the arcuate abrasive segments resiliently mounted around a center with a continuous groove therein,

FIG. 4 is an enlarged cross sectional view through the locking groove in one of the segment locating and retaining members and showing the engaging locking portion of a segment support member located around and displaced radially into the locking groove to prevent axial displacement of the retaining member,

FIG. 5 is a fragmentary cross sectional view of a segmental cut-off grinding wheel showing another embodiment of the invention wherein there are a plurality of grooves angularly spaced in the center and abrasive segments with segment support members inserted therein of another configuration adapted thereto,

FIG. 6 is a fragmentary cross sectional view showing another embodiment of a segment locating and retaining member with chamfered aligning surfaces on opposite sides of the locking groove engaged and aligned by the segment support member,

FIG. 7 is a fragmentary cross sectional view showing another embodiment of a segment support member with a double chamfered segment locating aperture for aligning a generally U-shaped rectangular locking groove in the segment locating and retaining member therewith,

FIG. 8 is a fragmentary cross sectional view showing another embodiment of a segment locating and retaining member with V-shaped segment locating surfaces and locking grooves aligned by the engaging double chamfered surfaces of a segment support member with a double chamfered locating hole, and

FIG. 9 is a fragmentary cross sectional view showing another embodiment of a segment locating and retaining member with a modified form of a substantially V-shape locking groove and locating surfaces engaged and aligned by a segment support member with straight non-beveled locating apertures.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring to FIGS. **1**, **2** and **6** there is shown a segmental cut-off grinding wheel **10** of relatively large diameter which may be anywhere between 2 to 6 feet and have an axial thickness of between one/fourth to three/fourths of an inch. The wheel **10** comprises a thin rotatable, reusable, drive cylinder, center, disc or hub **12** with suitable means, such as, a center hole **12***a*, for mounting the wheel **10** on a suitable rotatably driven spindle of a cut-off machine. As shown, the reusable drive center **12** is generally of circular shape and has opposite sides or surfaces **12***b* and **12***c* extending radially outward from the center hole, about the axis of the center, to a peripheral or circumferential surface **12***d* of the center. Extending radially inward from the peripheral surface **12***d* there may be one or more narrow segment aligning grooves **12***e* of predetermined substantially uniform axial width of between 0.040 – 0.375 of an inch located between and at substantially equal distance from the opposite sides. As shown in FIGS. **3** and **6**, the narrow aligning groove **12***e* may be one which extends either continuously around or one of a plurality of identical grooves angularly spaced around the center and extending a predetermined substantially uniform radial depth of between 1 – 4 inches to a circular or straight bottom surface **12***h* of predetermined diameter or radius, from the axis at the bottom of the groove which separates and provides a pair or set of axially spaced opposed side flange portions **12***f* and **12***g* on the center. Preferably, the center is a steel disc which may be made out of conventional saw steel and pretensioned in the conventional way as by rolling or peening to stiffen and increase its rigidity. Through the side flange portions **12***f* and **12***g* are a plurality of equally spaced groups of axially aligned apertures **12***j* and segment locating and retaining members **14** slideably mounted therein of substantial identical size and shape with the axes of each group of members and apertures spaced on a first base circle bc of predetermined radius or diameter.

The segment locating and retaining member **14** has an axial thickness or length no greater than that of the center **12**, and a locking groove **14***a* and segment locating surface **14***b* therein of predetermined radial depth and axial width, substantially the same as the narrow aligning groove **12***e*. The locking groove **14***a* is located substantially equal distances from its opposite ends and between opposing sides of spaced flange or end portions **14***c* and **14***d* of the member **14** engaging the center **12** within the apertures **12***j*. The members **14** have peripheral edges at its opposite ends and opposing sides of the groove **14***a* smoothed and slightly rounded off for guiding them into proper engagement with the other cooperating elements of the wheel.

Mounted on, equally spaced around and secured to the reusable hub or drive center **12** are a plurality of identical interchangeable and replaceable composite resin bonded abrasive segments **30** inserted into one or more grooves **12***e*. Each composite segment **30** comprises a thin segment base member or shoe **32** with an outer or upper radial portion **32***a* embedded in, interlocked with and resin bonded to the lower central portion of an abrasive portion, member or element **34**. In some instances the abrasive segments are strong enough and do not require additional reinforcement. However, if necessary or preferred at least one layer of reinforcing material **36** may be bonded to a side of the base member and extends radially through the abrasive portion **34** bonded thereto, to the outer circular peripheral or circumferential surface of the composite segments **34** and grinding wheel **10**. The segment base member **32** may be either a one piece or a laminated structure of suitable high strength material, for example, metal, plastic, reinforced plastic, and fiber glass.

The segment base member as shown in FIG. 2 and 3 is an arcuate or fan shape piece of metal selected from a group consisting of spring steel but may be a laminated structure made of resin bonded layers of either open or closed mesh fiber glass cloth or fiber glass woven roving as disclosed in the above mentioned copending application to which reference may be had for details not disclosed herein. The metal segment base

member 32 has on its upper radial portion 32*a* means for interlocking the abrasive portion or member 34 thereto comprising a plurality of apertures or holes 32*b* through which the resin bonded abrasive material extends and interconnects opposite sides of the abrasive member 34. Projecting radially inward from the under side or inner side and smallest radius of the arcuate abrasive portion 34 is a lower segment mounting portion or tongue portion 32*c* of the segment base member 32. The mounting portion 32*c* extends into the space, groove or slot 12*e* formed between the inner surfaces of the flange portions 12*f* and 12*g* and has a plurality of spaced segment locating holes or apertures 32*d* with edges at the opposite end thereof smoothed and slightly rounded off to remove burrs and to guide the members 14 therein of the same size and shape as the apertures 12*j*. The holes 32*d* and their center or axes are spaced apart substantially the same as the apertures 12*j* and equal distances from the opposite radial end surfaces or edges of the tongue portion but displaced radially to positions at a greater radial distance from the axis and onto a second base circle of larger diameter than the first base circle on which the equally spaced groups of apertures 12*j* are situated.

Resilient means are provided for biasing the segment base member and the abrasive portion fixed thereto radially outward relative to the center 12 to the second base circle position. Preferably the resilient means comprises a plurality of deflectable cantilever type springs or resilient members 32*g* and 32*h* integral with and formed in the lower portion of the tongue portion 32*c* on which there is a pair of inclined inner surfaces or diverging inner surfaces or edges for engaging the circular or bottom surface 12*h* at the bottom of the groove 12*e* in the center. There are also a pair of elongated slots 32L and 32*m*, situated a predetermined distance from the diverging surfaces to provide a cantilever spring member of sufficient width and strength which upon being deflected and preloaded thereby will force and maintain the abrasive segment base member in locking engagement with the locating surface 14*b* in the locking groove 14*a* and side surfaces of the flange 14*c* and 14*d* of the segment locating and retaining member 14. The slots 32L and 32*m* must also be of sufficient predetermined width to provide enough room for deflecting the springs 32 sufficiently to axially align the locating aperture 32*d* in the segment base member 32 with the apertures 12*j*. When aligned, the tongue portion 32*c* of member 32 is out of the locking groove whereby the locating and retaining member 14 is unlocked and can be displaced axially for the purpose of either attaching or detaching an abrasive segment respectively to or from the reusable center 12.

Forcing and displacing the abrasive segments inwardly sufficiently to align the apertures for inserting a segment locating member 14 therein deflects the springs 32*g* and 32*h* an amount greater than the depth of the locking groove 14. As a result, the displacement preloads the resilient springs sufficiently to provide a sufficient amount of reserve force which upon releasing the segment 30, displaces the segment base member outwardly into the locking groove 14*a* and precise locating engagement with the segment locating surface 14*b* and prevent axial displacement of the member 14. During high speed rotation and grinding or cutting with the wheel 10, centrifugal force being greater than the opposing grinding forces continues to maintain the segments in a precise position and driving engagement with the segment locating and retaining members 14. The force exerted by the cantilever springs must be greater than the weight of the segments so that the apertures cannot align and allow the escape of the members 14 when the wheel 10 is at rest.

Alternatively, more than two segment locating members 14 can be used to attach an abrasive segment and the geometrical shape of the member 14 and apertures 12*j* and 32*d* can be varied. For example, triangular, square, hexagonal, octangular and other non-circular cross sections can be used and would be more resistant to turning than the more economic easily formed circular or cylindrical shape disclosed.

A number of ways of providing resilient members integral with the segment member as well as those which are separate therefrom or integral with the center are possible. For example, the integral diverging cantilever springs could be separated from the segment support member by cutting through the section connecting the slots 32L and 32*m* and thereby provide a separate preloaded leaf spring between the surface 12*h* and tongue of the segment support member 32*c*. Abrasive portion 34 of the segment 30 can be made by molding it to the desired shape or preforming and bonding together suitable layers of an abrasive mix or mixture containing at least abrasive particles and a resinoid bonding material such as a thermosetting phenolic resin. The abrasive particles may be natural or synthetic diamond, metal oxide, and carbide materials such as alumina, alumina-zirconia, silicon carbide, boron carbide, tungsten carbide, and mixtures thereof.

The composite segment 30 can be made in various ways but the preferred method is to simultaneously mold and bond the abrasive mix, the layer or layers of reinforcing material, and the upper portion 32*a* of a preformed segment base member together to the desired size and shape determined by the mold. For example, a typical conventional mold may have a mold cavity of the desired arcuate shape, depth and thickness of the abrasive portion 34 and means to precisely position and support the preformed segment base member 32 with or without the locating holes 32*d* predrilled therein so the outer radial portion 32*a* projects the desired distance into the cavity. First an outer layer of the abrasive mix of predetermining depth to form an outer side portion of the abrasive portion 34 is spread upon the bottom of the mold cavity. If two pieces of reinforcement are desired, one preformed piece of reinforcing material cut-out of a sheet of Lewcott No. 35 open mesh woven roving fiber glass cloth precoated wth like resinoid bonding material commercially available from Lewcott Chemical and Plastic Corporation, Millbury, Mass., is placed on the loose layer of mix. Then a preformed segment base member 32 with or without predrilled locating holes 32*d* is placed in and precisely located by the mold so that it extends into the cavity and over the reinforcing material the desired amount. More of the abrasive mix is spread to fill the space and form the central or inner layer between the outer edge of the segment base member and the mold wall and the interlocking holes 32*b* if present. Thereafter, either a final outer layer of abrasive mix is spread thereover or a second piece of preformed reinforcing glass cloth is first laid over the central or inner layer and a side of portion 32*a* followed by spreading a final outer layer of the abrasive mix thereover. The mold

cavity is then closed with a suitable mold pressing plate and the mold placed between heatable platens of a conventional hot press, where the abrasive mix, including the resin bond, the reinforcement and the segment base member are not pressed and resin bonded into a unitary composite segment of the desired size and shape at a pressure of ½ to 1 ton per square inch and temperature of 165°C for 15 minutes.

The hot pressed composite segment is then stripped or removed from the mold and placed in an oven for a predetermined period of time at a predetermined temperature to thoroughly cure the thermosetting resin bond. The locating holes **32***d* may be machined in the preformed segment support **32** before molding or after the molded segment is cured, by placing it in a suitable precision drill jig or fixture for locating and drilling the segment locating holes **32***d*. When the holes **32***d* are predrilled the mold obviously has means, such as, locating pins to properly position the holes **32***d*.

Alternatively, the abrasive segment **30** may have laminated fiber glass segment support members **32** and made by either hot or cold pressing the components together and curing the resin in the manner disclosed in the above mentioned copending applications to which reference may be had for details including an example of a suitable abrasive mixture not disclosed herein.

Another embodiment of the invention is disclosed in FIG. **5** which is a partial cross sectional view through a portion of a segmental cut-off wheel **10** comprising a circular drive center **12** with a plurality of identical narrow segment aligning grooves, pockets or slots **12***e* of relatively short arcuate length angularly spaced, substantially equally around the peripheral or circumferential surface **12***d*. Between and separating the narrow grooves **12***e* are a plurality of ties, spacers or connecting webs **12***w* which may be separate elements fixed to but preferably formed integrally with the center **12** extending axially between the opposite sides **12***b* and **12***c* and a plurality of sets or pairs of opposed spaced side flange portions **12***g* and **12***f* angularly spaced thereby around the center **12**. In this embodiment each of the grooves **12***e* extend a predetermined radial depth from the peripheral surface **12***d* to the bottom surface **12***h* of predetermined radial distance from the axis of the center. The bottom surface **12***h* is substantially straight, extends between and connected to two opposite concave or curved radial end surfaces **12***y* of adjacent spacers or webs **12***w* at the angularly spaced ends of the groove. Each curved side or end surface **12***y* has a portion with a curvature of predetermined radius determined by the diameter of the rotary cutter used to machine the slots in the center and extend from the bottom surface **12***h* to the peripheral surface **12***d*.

Inserted into each of the spaced grooves **12***e* is an abrasive segment **30** which differs from the segment **30** shown in FIG. **3** only in the configuration of the tongue portion **32***c*. As shown the tongue portion **32***c* of the segment support member **32** has a configuration similar to and adapted to fit the groove, and convex or curved shaped radial end surfaces **32***r* spaced from the concave surfaces **12***y* of the webs **12***w*, engaging cantilever springs **32***g* and **32***h* of shorter length than those shown in FIG. **3**. In effect each of the opposite radial end corner portions of the tongue portion **32***c* of the segment shown in FIG. **3** has been removed and rounded off to provide the abrasive segment **30** shown in FIG. **5**. As a result the cantilever springs are slightly stiffer and thereby displaces the segment support member with slightly greater force radially into engagement with the locating surface **14***b* of the segment locating and retaining members **14**. However, it is obvious that the dimension of the cantilever springs can be modified to either increase or decrease the amount of force exerted thereby.

Except for the modifications described above the abrasive segments **30** and center **12** shown in FIG. **5** are identical in every other respect to the segment **30** and center **12** shown in FIG. **3** and attached and detached to and from the center **12** in the same manner described above.

Various embodiments of aligning guide means for the segment locating and retaining means **14** are shown in FIG. **6** through **9** inclusive and which guide means provide for more positively aligning the locking groove with the segment support member and the center.

In FIG. **6** there is shown a modified form of a segment locating and retaining member **14** which differs from the one shown in FIG. **2** in that it has a tapered, beveled or chamfered surface **14***t* extending between each of the side surfaces **14***c* and **14***d* and the peripheral surface instead of and replacing the corner formerly at the junction thereof. The chamfers, tapers or bevels **14***t* of a misaligned member **14** may be engaged by corners of the segment support member at opposite ends of the locating aperture **32***d* and thereby axially shift the member **14** sufficiently to allow the segment support member **32** into the generally U-shaped rectangular locking groove **14***a*, locating engagement with the locating surface **14***b*, locking engagement with the side surfaces **14***c* and **14***d*, and to positively align and/or center the retaining member **14** with the center **12**.

In FIG. **7** there is shown a portion of the tongue portion **32***c* of a segment support member modified to provide tapered, chamfered or beveled surfaces **32***t* at opposite ends of the locating aperture **32***d*. The chamfers or bevels or tapers **32***t* extend from the internal locating surface of the aperture **32***d* to each opposite side or surface of the segment support member **32** and replace corners formerly at the junction thereof. In this instant the incline surface of the chamfers **32***t* may engage the corners at the junction of the sides **14***c* and **14***d* with the peripheral surface thereon and thereby axially shift a misaligned locking groove and member **14** into alignment with the segment support member **32** and the center **12**.

Another version of a segment locating and retaining member **14** is shown in FIG. **8** having both a V-shape locking groove and locating surfaces **14***v* adapted for mating locating and locking engagement with the mating inclined surfaces, tapers, bevels or chamfers **32***t* at opposite ends of the locating aperture **32***d*. The locating V-shape groove **14***v* is of substantially the same axial width as the groove **12***e* and a misaligned member **14** is axially shifted by the forceful engagement of the surfaces of the taper or chamfer **32***t* with the V-shape locking surfaces **14***v*.

Another generally V-shape segment locking groove and locating surfaces **14***u* connected by a concave surface at the bottom of the groove and of greater axial width than the groove **12***e* in the center **12** and thickness of the engaging tongue portion **32***c* of a segment support member **32** with a straight non-chamfered locating aperture and internal surface **32***d* therein extending between the opposite sides thereof.

As used herein, a generally U-shape rectangular locking groove, is intended to also include and define a groove formed by removing a portion of substantially square or rectangular cross section from the member **14** and with the sides **14***c*, **14***d* at substantially right angles to the locating surface **14***b*.

The preloaded cantilever springs force the corners or edges at opposite ends of the apertures **32***d* in the tongue into engagement with the V-shape surface **14***u* and thereby axially shifts the member **14,** precisely locates the segment support member **32** relative to the center and locks the member **14** against any further axial displacement.

Identical arcuate composite abrasive segments **30** with segment support members made from C–1075 hard cold rolled spring steel with a hardness of between C22 and C33 measured on the Rockwell scale embedded approximately 1 inch into the abrasive portions **34** and with precise dimensions necessary to make them interchangeable have been formed having an outer peripheral radius of 15–17/32 inches, an inner radius of 11–17/32 inches at the abrasive shoulders overhanging the opposite sides of the tongue of the metal segment support member with ⅛ inch wide slots, adjacent cantilever springs 0.100 of an inch and diverging surfaces equally inclined 69½° from a central radial plane, passing through a central portion of the tongue adapted to engage a bottom surface **12***h* 9½ inches in radius from the axis of a stainless steel center 11-15/32 inches in radius. The abrasive section **34** being ¼ of an inch in axial thickness × 4 inches in radial width or depth and the tongue portion **32***c* 0.050 of an inch thick and varying to approximately 2 inches in radial depth with the abrasive section **34** overhanging the sides of the tongue equally, approximately 0.100 of an inch and with included angle of approximately 35° between the radial ends or edges.

Excess cured thermosetting phenolic resin flash or material is removed from the precisely formed composite segment. Each segment member **32** has two 0.625 of an inch diameter segment locating apertures machined therein with their axes spaced 3.375 of an inch between centers measured on a chord 10.494 inches from the axis of a base circle or arc with a radius of approximately 10-11/16 inches (21⅜ inch in diameter) with the axes of the end holes substantially equal distances from the radial ends or edges of the segment and from each of a pair of radial planes spaced 36° apart passing between adjacent segments **30** of the grinding wheel **10.** Both of the opposite edges, corners, or end surfaces of the apertures **32***d* and **12***j* are smoothed or rounded off to remove any burrs which prevent insertion of the retaining member **14.**

The composite segments **30** are preferably of shorter arcuate length than the length of an arc extending between each pair of radial planes spaced at, predetermined equal angles of 36° around the axis of the hub **12.** Thus when mounted on the hub **12** the segments **30** will be spaced from one another and have a space in this specific embodiment of about one/fourth of an inch.

Ten interchangeable composite abrasive segments **30** of the dimensions given above are then mounted on a one piece reusable steel drive center or hub **12** with the following approximate dimensions: outside diameter of 22-15/16 inches, axial thickness of 0.200 of an inch, a center hole 4 inches in diameter, one or a plurality of angularly spaced segment aligning grooves 0.053 of an inch wide by 1-31/32 inches in radial depth either to a circular surface or bottom surface 9½ inches in radius from the axis at bottom of the groove. There are 10 equally spaced identical groups of two apertures each or a total of 20 apertures 0.626 of an inch in diameter and 20 segment locating and retaining member 0.621 of an inch in diameter by 0.200 of an inch long with a central locking groove 0.053 of an inch wide by 0.032 of an inch deep in the apertures with the axes of each group of apertures spaced 3.375 inches measured on a chord 10.494 inches from the axis of a base or bolt circle *bc* approximately 10-11/16 inches in radius and 21⅜ inches in diameter.

When the composite abrasive segments **32** are assembled on the hub of the dimensions described above, by example only, and radially displaced outwardly one thirty-second of an inch relative thereto by the preloaded resilient springs, they produce a segmental cut-off grinding wheel with an outside diameter of 31-1/16 inches, 10 equally spaced abrasive segments 0.250 of an inch thick with sides lying in a single plane about and normal to its axis of rotation and with a center hole 4 inches in diameter. The axes of each group of segment locating apertures in the tongue portions are likewise displaced 0.032 of an inch or the amount equal to the depth of the locking groove from the axes of the group of apertures in the center spaced 3.375 inches apart measured on a chord 10.494 inches from the axis of a base circle bc approximately 10-11/16 inches in radius. Hence, the new or displaced positions of the apertures place their axes to lie 3.375 inches apart measured on a chord 10.526 inches from the axis of the center and on a base circle *bc'* of a greater radius of approximately 10-23/32 inches from the axis of the center. When the segments **30** have but one reinforcing member **36,** the segments are preferably assembled so that the reinforcing members of adjacent segments are staggered and alternately shifted from a position adjacent one side of the wheel to a position adjacent the opposite side. Hence all the reinforcement, does not lie in a single non abrading plane but is interrupted by at least one but preferably by a plurality of abrading portions of adjacent segments.

During rotation and forcing the segmental cut-off wheel to cut or grind through material, centrifugal force greatly exceeds the applied cutting or grinding forces required by an order of magnitude of approximately 10 to 1. Therefore, the greater outward force prevents the abrasive segments from being displaced inwardly, thereby maintaining the segment support member **32** within the locking groove and locking the members **14** to the center **12.**

Obviously, larger segmental cut-off wheels than the specific examples of the invention given above can be made by modifying the dimensions of the segments and the hub to accommodate greater numbers of composite segments required to complete the wheel of greater diameter and circumference. Also, the number and diameter of the segment locating and retaining member may be varied so long as there is sufficient strength in the total sectional area thereof to effectively oppose the calculated centrifugal load or force exerted by each abrasive segment rotating at the desired predetermined number of surface feet per minute.

Although the invention has been illustrated and described in specific embodiments, it is to be understood

that many variations of and changes may be made therein without departing from the invention set forth in the following claims.

What is claimed is:

1. A relatively large segmental cut-off grinding wheel comprising:

a relatively large, thin reusable drive center rotatable about its axis having

a peripheral surface,

opposite sides extending to the peripheral surface,

at least one narrow segment aligning groove of predetermined axial width extending inwardly from the peripheral surface a predetermined radial depth to a bottom surface extending axially between opposing inner sides of opposed spaced side flange portions of the center, a plurality of axially aligned apertures of predetermined size and shape extending axially through the side flange portions with axes situated and spaced on a first base circle of predetermined radius from the axis;

a plurality of interchangeable and replaceable composite abrasive segments mounted around, attached to, and displaceable radially relative to the center, each having

a bonded abrasive portion of predetermined axial thickness,

a segment base member having

an outer radial portion fixed to an inner radial portion of the abrasive portion, a tongue portion, radially displaceable relative to the center, extending radially inwardly from the abrasive portion and slideably into the narrow segment aligning groove,

a plurality of segment locating apertures, in the tongue portion of substantially the predetermined size, shape and spacing between their axes as the axially aligned apertures in the opposed spaced side flange portions and displaced radially so their axes lie substantially on a second base circle of greater radius than the first base circle of predetermined radius from the axis of the center;

a plurality of axially movable segment locating and retaining members slideably mounted within the axially aligned apertures in the side flange portions of the center and extending axially through the locating apertures in the segment support member radially displaced into engagement therewith and each having

a locking groove, including a segment locating surface engaged by the displaced segment support member therein, of predetermined depth between opposing inner side of spaced end portions of the segment locating and retaining member; and

resilient means engaging the center for biasing and displacing

each of the segment support members radially outward relative to the center into engagement with the segment locating surface in the locking groove and maintaining the abrasive segments in a precise radial position on the center,

whereby the segment locating and retaining members are engaged, locked in place, and prevented from shifting axially by engaging portions of the segment support members biased into the locking groove and the abrasive segments may be quickly attached and detached from the center by radially displacing them inwardly against the resilient means sufficiently to shift the axes of the locating aperture from positions on the second base circle into axial alignment with the axes of the apertures in the side flange portions situated on the first base circle, and the segment support member out of the locking groove therein and sufficiently displacing the segment locating and retaining members axially relative to the center.

2. A segmental cut-off grinding wheel according to claim 1 wherein the resilient means comprises:

a pair of cantiliver spring members on the tongue portion of the segment support member each having

an end portion anchored to a lower portion of the tongue portion; and

an elongated deflectable portion extending longitudinally from the anchored end portion, displaced into forceful engagement with the center within the narrow aligning groove sufficiently to exert a force necessary to displace and maintain the segment support member radially outward against the segment locating and retaining members.

3. A segmental cut-off grinding wheel according to claim 2 wherein the cantilever spring members are an integral part of each segment support member comprising:

a pair of the narrow elongated deflectable portions extending longitudinally in opposite directions from a central lower anchor portion of the tongue portion along and including the lower inner edge of the tongue portion toward opposite radial ends of the tongue portion and displaced into engagement with the center within the narrow groove; and

a pair of elongated slots adjoining the deflectable portions and extending a predetermined depth from the opposite radial ends of the tongue portion.

4. A segmental cut-off grinding wheel according to claim 1 wherein the center has

one continuous narrow segment aligning groove extending circumferentially around the center and into which each of the segment support members are slideably mounted, and

wherein the plurality of axially aligned apertures are arranged into

a plurality of groups equally spaced around the center, each group having

an identical number of at least two of the axially aligned apertures with their axes situated and spaced on the first base circle, extending axially through the spaced opposed side flange portions.

5. A segmental cut-off grinding wheel according to claim 1 wherein the center has

a plurality of narrow segment aligning grooves of predetermined arcuate length angularly spaced around the center and extending radially inward from the peripheral surface a predetermined radial depth to bottom surfaces extending axially between opposing inner sides of a plurality of angularly spaced sets of spaced opposed side flange portions of the center;

a plurality of spacers extending radially between and separating the plurality of narrow segment aligning grooves and sets of the spaced opposed side flange portions; and

wherein the plurality of axially aligned apertures are arranged into

a plurality of groups equally spaced around the center, each group having

an identical number of at least two of the axially aligned apertures, with their axes situated and spaced on the first base circle, extending axially through each set of the plurality of angular spaced sets of the spaced opposed side flange portions of the center.

6. A relatively large segmental cut-off grinding wheel according to claim **5** wherein the spacers between the segment aligning grooves are an integral part of the center and have

curved side surfaces of predetermined curvature at opposite angularly spaced radial ends of the narrow aligning grooves extending from the bottom surfaces to the peripheral surface of the center and defining the configuration of the narrow segment aligning groove; and

wherein the tongue portion of the segment support members have

curved radial edges spaced from and corresponding substantially to the curvature of the curved side surfaces; and

a configuration corresponding substantially to the configuration of the narrow aligning grooves.

7. A relatively large segmental cut-off grinding wheel according to claim **1** wherein the locating apertures in the tongue portion have

substantially straight internal locating surfaces extending between opposite ends and edges thereof at opposite sides of the tongue portion; and

wherein the segment locating and retaining member may selectively have

generally U-shape rectangular locking grooves and V-shape locking grooves and locating surfaces for selectively engaging the straight internal locating surfaces and the edges of the locating apertures.

8. A relatively large segmental cut-off grinding wheel according to claim **1** further comprising

guide means, including portions of the tongue portion at opposite ends of the locating apertures and portions of opposing inner sides of the locking groove, for engaging one another and aligning the locking groove in the segment locating and retaining members with the tongue portion.

9. A relatively large segmental cut-off grinding wheel according to claim **8** wherein the guide means comprises:

beveled surfaces in the portion of the tongue portion at opposite ends of the locating apertures in the tongue portion.

10. A relatively large segmental cut-off wheel according to claim **9** wherein the segment locating and retaining members have

V-shape locking grooves and locating surfaces adapted for mating locating and locking engagement with the beveled surfaces at opposite ends of the locating apertures in the tongue portion.

11. An interchangeable and replaceable composite abrasive segment adapted to be mounted around, attached to, and displaceable radially relative to a relatively large thin reusable rotatable drive center having an axis, at least one narrow segment aligning groove of predetermined axial width extending inwardly from a peripheral surface a predetermined radial depth to a bottom surface extending axially between opposing inner sides of opposed spaced side flange portions of the center, a plurality of axially movable segment locating and retaining members, each with a segment locking groove and locating surfaces therein between opposing inner sides of spaced end portions thereon slideably mounted within axially aligned apertures in the side flange portions of the center with axes situated and spaced on a first base circle of predetermined radius from the axis and the composite abrasive segment comprising:

a bonded abrasive portion of predetermined axial thickness;

a segment base member having

an outer radial portion fixed to an inner radial portion of the abrasive portion, a tongue portion extending radially inwardly from the abrasive portion adapted to be inserted and slideable into both the segment aligning groove and the locking groove and displaced radially into locking and locating engagement with the locating surface in the segment locating and retaining members in the center, a plurality of segment locating apertures and locating surfaces in the tongue portion of substantially the size, shape and spacing between their axes on the first circle as the axially aligned apertures in the opposed spaced side flange portions and through which the segment locating and retaining members pass and engage the locating surfaces in the tongue portion; and

resilient means, on the tongue portion, for forcefully engaging the center within the segment aligning groove preloaded by displacing the abrasive segment sufficiently to align the locating and axially aligned apertures and inserting the segment locating and retaining members therein and upon releasing the abrasive segments for biasing and radially displacing the tongue portion outwardly relative to the center into the locking groove to maintain the locating surface of the tongue portion in locating engagement with the locating surface of the segment locating and retaining members which are thereby locked in place against axial movement relative to the center and shift the axes of the locating apertures to positions on a second base circle of greater radius from the axis of the center.

12. An interchangeable and replaceable composite abrasive segment according to claim **11** wherein the resilient means comprises:

a pair of cantilever spring members on the tongue portion of the segment support member each having

an end portion anchored to a lower portion of the tongue portion; and

an elongated deflectable portion extending longitudinally from the anchored end portion displaced into engagement with the center within the narrow aligning groove and deflected sufficiently to exert a force necessary to displace the segment support member radially outward against the segment locating and retaining members.

13. An interchangeable and replaceable composite abrasive segment according to claim **12** wherein the cantilever spring members are an integral part of each segment support member comprising:

a pair of narrow elongated deflectable portions extending longitudinally in opposite directions from

a central lower anchor portion of the tongue portion along and including the lower inner edge of the tongue portion toward opposite radial ends of the tongue portion and displaced into engagement with the center within the narrow groove; and a pair of elongated slots adjoining the deflectable portion and extending a predetermined depth from the opposite radial ends of the tongue portion.

14. An interchangeable and replaceable composite abrasive segment according to claim **11** wherein locating apertures in the tongue portion have:

substantially straight internal locating surfaces extending between ends and edges thereof at opposite sides of the tongue portion for selectively engaging the locating surfaces in both generally U-shape rectangular locking grooves and V-shape locking grooves in the segment locating and retaining members selected for use therewith.

15. An interchangeable and replaceable composite abrasive segment according to claim **11** wherein the tongue portion further comprises:

beveled locating and locking surfaces at opposite ends of the locating apertures adapted for mating engagement with V-shaped locking grooves and surfaces in the segment locating and retaining members.

16. An interchangeable and replaceable composite abrasive segment according to claim **11** wherein the tongue portion further comprises:

guide means at opposite ends of the locating apertures for engaging portions of opposing inner sides of the locking groove and aligning the locking grooves in the segment locating and retaining members therewith.

17. An interchangeable and replaceable composite abrasive segment according to claim **16** wherein the guide means comprises:

beveled surfaces at opposite ends of the locating holes in the tongue portion.

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