Feb. 25, 1964 H. C. MILLER 3,121,982

GRINDING WHEEL WITH ADJUSTABLE ABRASIVE SEGMENTS

Filed Aug. 25, 1960 2 Sheets-Sheet 1

Fig. 1

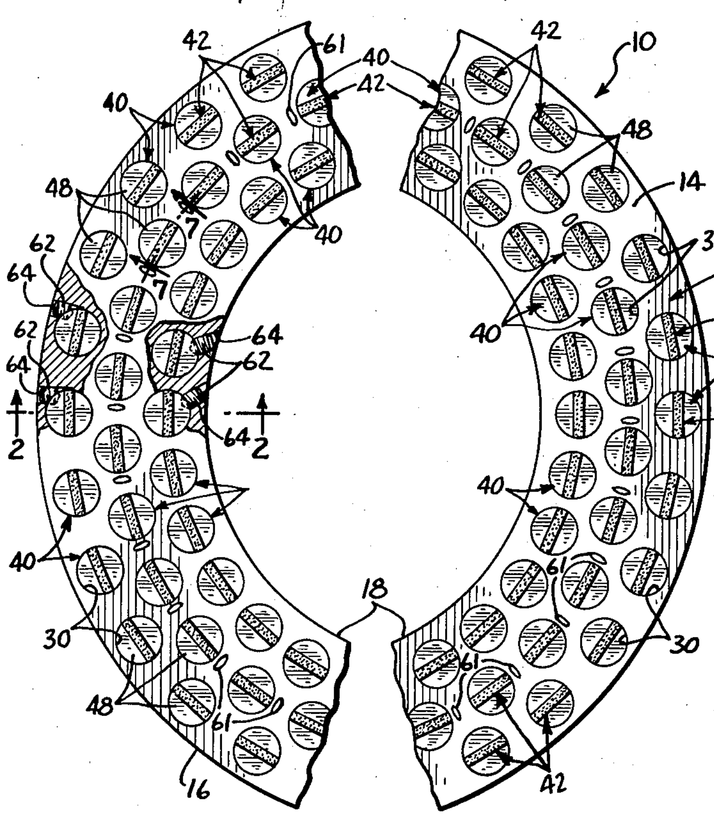


Fig. 3

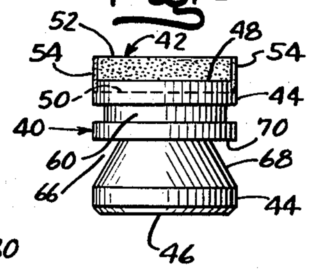


Fig. 4

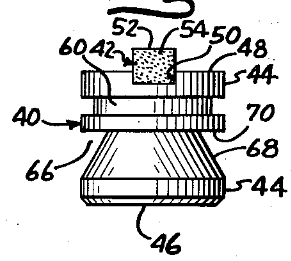


Fig. 2

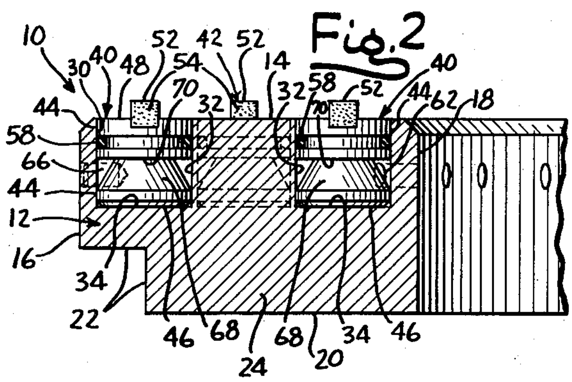


Fig. 5

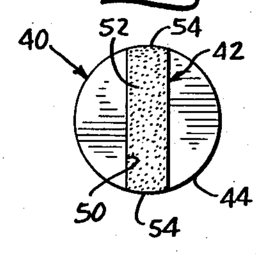


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Fig. 6

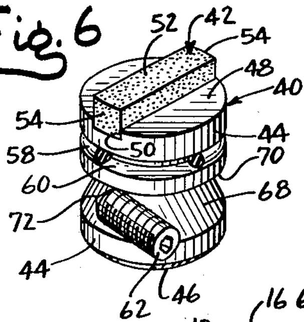



Fig. 7

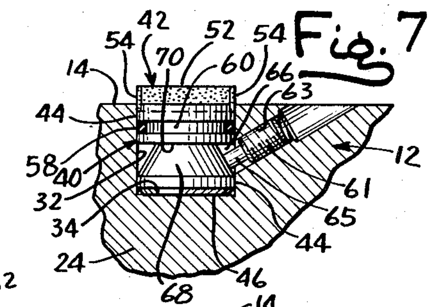



Fig. 8

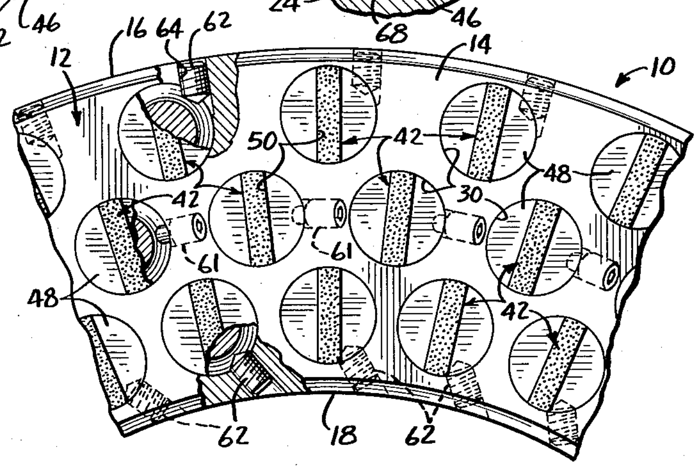
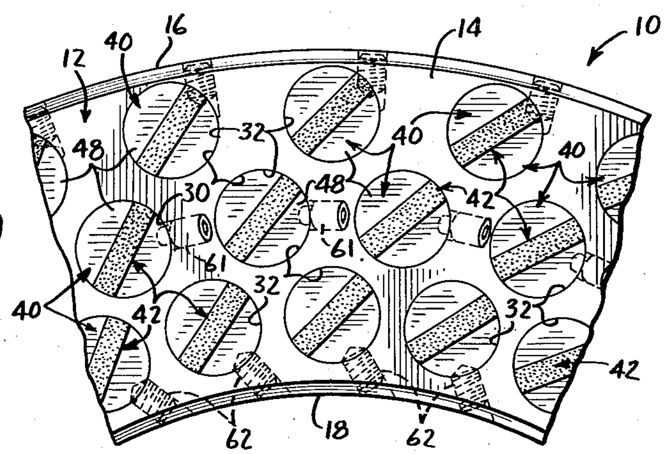



Fig. 9





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United States Patent Office

3,121,982
Patented Feb. 25, 1964



# 3,121,982
# GRINDING WHEEL WITH ADJUSTABLE ABRASIVE SEGMENTS

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Filed Aug. 25, 1960, Ser. No. 51,940
7 Claims. (Cl. 51—209)

The present invention relates to rotary grinding wheels of the type commonly employed for grinding materials such as ceramics, glass, carbides, ferrites and the like and has particular reference to that type of grinding wheel which employs a series of appropriately shaped abrasive segments which are positioned in coplanar relationship on the planar or other operative working surface of a grinding wheel body according to a predetermined geometrical pattern. Grinding wheels constructed in accordance with the principles of the present invention are capable of being installed for operative use in connection with a wide variety of commercial grinders such as Blanchard or Besley grinders, suitable adapters being provided when necessary.

In connection with grinding wheels of the character briefly outlined above, there are many variables which must be considered in connection with the selection of a grinding wheel suitable for the performance of a particular character of work. Principal among these variables are the number of abrasive segments employed, the disposition or placement of these segments collectively on the face of the wheel body, i.e., the spacing thereof from one another and from the axis of rotation of the wheel, the composition and particularly the particle size and concentration of the abrasive material of the individual segments, the shape and size of the individual segments, i.e., the outline of their working faces, the angular relationship of the segments, i.e., the direction of their elongation, the speed of rotation of the grinding wheel, the rate of advancement or feed of the wheel toward the work, the character of the feed, i.e., continuous or intermittent, and other lesser variables too numerous to mention.

There are no formulae involving all of these variables as factors and by means of which it is possible to predetermine the character of a grinding wheel which is most suitable for the performance of work on a given object or set of objects. Except in a very general way, even the most experienced technician is unable to predict the quality of work which will be performed by any given wheel. For example, a grinding wheel which is quite satisfactory in its performance when used in a machine having provision for continuous feed, may prove worthless when used in a machine having provision for intermittent feed. A grinding wheel which performs well on work of a given hardness may exert damaging effects on similar work but of a different degree of hardness. A wheel having a given number of segments, for example, thirty-six segments and which, because it has worked satisfactorily in connection with the performance of a given character of work on articles of a given composition or shape, would ordinarily be expected to give equally good performance where similar work is to be performed on similar articles but of a different composition or shape, will frequently be found to render a most unsatisfactory finish where the different work is concerned. A change from thirty-six to seventy-two segments may be all that is required to produce a satisfactory grinding wheel. A slight change in the direction of orientation of the individual segments on the face of the wheel may suffice, or it may require a change in one or more of any of the other variables mentioned above.



Since even the most experienced operator is unable to predict grinding wheel performance before the wheel is actually put to use, it follows that grinding wheel design is invariably an empirical matter. Because of the fact that the various abrasive segments are invariably cemented, soldered or otherwise fixedly bonded to the working face of the grinding wheel, the cost of producing a suitable wheel for a given character of work by empirical methods is extremely high both from the standpoint of engineering talent and skilled labor, to say nothing of the cost of materials involved, work experimentally consumed and shipping costs to and from the factory for repeated trials. It frequently happens that before a single wheel can be produced for satisfactory performance, a dozen or more experimental wheels must be manufactured, thus consuming substantial time.

Due to the high cost of the wheel bodies and the abrasive segments which are applied thereto, the experimental work conducted in the production of a given grinding wheel is usually performed on the basis of a single wheel body to which the segments are applied experimentally at the factory and shipped to the project in the field. The same wheel body is shipped to and from the field until it is reported that the same is satisfactory. In many instances, the technicians follow the wheel and observe its performance so that they may more intelligently deal with the problem and suggest the necessary alterations in segment substitution or segment pattern arrangement.

Because of the distance involved, which may span oceans, the high cost of transportation of both the wheel and any technicians who may be assigned to the project, frequently leads the manufacturer to accept for production purposes a wheel design, i.e., a geometrical arrangement of segments or a group of segments of a given composition, which although satisfactory to a degree, is not the ultimate in perfection. The cost of dismantling and reassembling a wheel one or more times to attain perfection of performance when the wheel at hand has finally given performance that is merely passable may, in the manufacturer's mind, not warrant the further expense of additonal experimental work.

The variables which are outlined above and affect the character of the finish produced on a given sort of work are of two kinds. One set of variables is concerned with the nature and disposition of the segments on the grinding wheel body and the other set relates to such independent factors as speed of rotation of the grinding wheel, the character of feed, the character of the coolant employed, and ambient conditions of temperature. The present invention is concerned primarily with variables of the first-mentioned type and the invention provides a novel means whereby such variables, as, for example, collective segment placement, segment substitution, and individual segment orientation, may be experimented with in an extremely convenient manner during the necessary empirical procedures that are required to produce the best possible geometrical disposition of segments on the working face of a grinding wheel for optimum results in connection with a given character of work.

Briefly, the present invention contemplates the provision of a grinding wheel, the body of which has formed therein or associated therewith a series of cylindrical sockets which are arranged in a predetermined pattern and are designed for selective reception therein of a series or group of generally cylindrical segment-carrying, holder-type inserts with means being provided whereby each individual insert may be turned within its respective socket and anchored therein in any desired position of angular adjustment.

In the illustrated form of the invention herein, as is the usual disposition of fixed segments on the working face of conventional grinding wheels, the sockets are arranged in circumferentially spaced relationship and in concentric rows on the working face of the wheel, and the segments are of elongated design. Thus, by turning the individual holder-type inserts in their respective sockets, the segments of each row may be arranged so as to project their axes tangentially of the circular row radially thereof, or at any desired secant angle with respect to the circular row. By such an arrangement, and by thus adjusting the various segment-carrying inserts in their respective sockets, all of the most commonly tried geometrical arrangement of segments on the face of a grinding wheel may be duplicated without dismantling the wheel, or, in fact, without even requiring that the segments be detached from the wheel assembly.

The advantages offered by an arrangement such as has briefly been outlined above are manifold and obvious. Principal among them is the fact that countless soldering and unsoldering operations are completely eliminated. The initial soldering or otherwise bonding of a segment to its respective insert is the only soldering or bonding operation that is required of that particular segment. Thereafter, the particular insert may be installed in any selected socket so that, in combination with other similar inserts, any desired placement pattern of segments may be attained, while at the same time, infinite angular adjustment of the individual inserts, and consequently of their attached segments, may be effected. Because of these considerations in the placement and adjustment of segment-carrying inserts on the working face of a grinding wheel, the labor saved in soldering time enables a finer experimental adjustment of segments than otherwise would be justified. Whereas for a given character of work experimental adjustment of segments progressively through angles of 20° may require a full week's work in arriving at a satisfactory segment pattern where conventional grinding wheels are concerned, with the grinding wheel of the present invention, experimental progressive adjustment of segments throughout angles of 5° may be accomplished in a matter of an hour or so, and in some instances, without necessitating removal of the grinding wheel from its mounting arbor.

Apart from the angular adjustment of segments for experimental work, the collective placement thereof on the wheel may similarly be varied without requiring soldering and unsoldering operations. The segment-carrying inserts are capable of being installed or removed from the wheel body at will to increase or decrease the number thereof or to alter the collective placement of the same.

A still further advantage of the present grinding wheel resides in the fact that each empirical adjustment of segments is a potential final adjustment which, when effected, conditions the wheel as a whole for immediate commercial use so that it is not necessary to remove the wheel to the bench in order further to strengthen the segment bonds.

Yet another advantage which accrues from the present invention resides in the fact that manufacturers may, with convenience, small storage space, and economy, keep on hand a quantity of the segment-carrying buttons, sorted and arranged according to size, abrasive concentration, shape, matrix hardness or composition, etc. and a relatively few wheel bodies of different sizes and socket arrangements, and with these parts and no other tools, other than a single suitable wrench, perform all of the experimental work ordinarily required as a preliminary to the production of a satisfactory grinding wheel with greater dispatch than is possible by a manufacturer having a large stock of conventional grinding wheels. For example, if the first wheel shipped to a given scene of operations does not prove altogether satisfactory, a technician may be dispatched to the field, carrying with him an assortment of segment-carrying inserts which he may apply to the wheel according to the dictates of his judgment to produce a satisfactory pattern of segments of the proper composition with all of the work being performed in the field and, in many instances, without even requiring removal of the existing segments from the working face of the wheel.



The provision of a grinding wheel of the character set forth above and possessing the stated advantages, being the principal object of the invention, it is a further and specific object to provide such a wheel having associated therewith novel means for locking the individual inserts in position within their respective sockets.

Another specific object of the invention is to provide a novel segment-carrying insert which readily lends itself to manufacture in quantity and with uniformity and in an economical manner so that all of the inserts are of uniform height within very fine tolerances whereby the working surfaces of the segments carried thereby will, automatically upon installation in a given wheel body, assume an accurate coplanar relationship.

Numerous other objects and advantages of the invention, not at this time enumerated, will become more readily apparent from a consideration of the following detailed description.

In the accompanying two sheets of drawings forming a part of this specification, one illustrative embodiment of the invention has been shown for exemplary purposes.

In the drawings:

FIG. 1 is a fragmentary bottom plan view of the working face of a grinding wheel constructed in accordance with the principles of the present invention and showing certain segment-carrying inserts associated therewith arranged according to a predetermined pattern;

FIG. 2 is a sectional view taken along the line **2—2** of FIG. 1;

FIG. 3 is a side elevational view of a segment-carrying insert employed in connection with the present invention;

FIG. 4 is a side elevational view similar to FIG. 3 but showing the insert from a different angle;

FIG. 5 is a top plan view of the button of FIGS. 3 and 4;

FIG. 6 is an exploded perspective view, somewhat schematic in its representation, illustrating the operation of certain insert-locking means employed in connection with the present invention;

FIG. 7 is a fragmentary section of the grinding wheel body showing one of the segment-carrying inserts of the wheel mounted in its respective socket and illustrating the manner and means for releasably locking the insert in place and also in its different angularly adjusted positions.

FIG. 8 is a fragmentary bottom plan view similar to FIG. 1 but showing the inserts arranged in a different angular relationship; and

FIG. 9 is a fragmentary bottom plan view similar to FIGS. 1 to 8 but showing the inserts in still another angular relationship.

Referring now to the drawings in detail, and in particular to FIGS. 1 and 2, a rotary grinding wheel embodying the principles of the present invention has been fragmentarily shown and designated in its entirety at **10**. The wheel **10** includes a wheel body **12** in the form of an annular steel or other metallic ring presenting a flat annular working face **14**, a cylindrical outside face **16**, a cylindrical inside face **18**, and an annular bottom face **20**. As shown in FIG. 2, the outer side of the body is relieved as at **22** to provide a reduced shank **24** by means of which the grinding wheel as a whole may be applied to a conventional grinding machine (not shown), as, for example, a Blanchard machine, or to a suitable adapter by means of which the wheel may be converted for use in different machines.

The working face **14** in most instances will face downwardly and the wheel will be advanced or fed to the work either by continuous increments of downward motion or by intermittent increments of downward motion. The wheel is thus illustrated herein in FIGS. 1 and 2 as being inverted for convenience of disclosure, but it will be understood that what are referred to herein as the upper and lower faces of the wheel may, in reality, be reversed when the wheel is put to use.

Still referring to FIGS. 1 and 2, the annular working face 14 of the wheel body 12 is provided with a plurality of relatively deep sockets 30 therein presenting cylindrical side walls 32 and flat circular bottoms 34. These sockets are precision machined within fine tolerances both as to depth and diameter for purposes that will be made clear presently.

The sockets 30 have been shown as being arranged in three concentric adjacent circular rows extending around the annular working face 14 with each row having an equal number of the sockets so that the spacing between adjacent sockets in the outer rows is slightly greater than the spacing between adjacent sockets in the inner row. The sockets of the three rows are shown as being staggered. It will be understood, however, that other socket placements or positions are contemplated and that a greater or lesser number of rows of sockets is contemplated. It is also contemplated that the number of sockets in each row may be varied at will. In certain instances, it may be found expedient to form the sockets in the annular working face 14 in various patterns not involving concentric rows of sockets. Irrespective, however, of the particular arrangement of sockets 30 on the working face of the wheel body, the essential features of the invention are at all times preserved.

The various sockets 30 are adapted selectively to receive therein a plurality of inserts 40 in the form of generally cylindrical members preferably formed of mild steel and each of which carries an abrasive segment 42. The cylindrical inserts 40 are preferably of the same height as the sockets 30 so that when a given insert is inserted in a selected socket 30, it will project a slight distance outwards of the flat working face of the wheel body. The over-all diameter of each insert 40 is only slightly less than the diameter of its socket 30 so that the inserts may fit within their respective sockets and have freedom of turning movement therein without tilting. As will be described in detail presently, means are provided for individually and releasably locking each insert 40 in its respective socket 30 in any desired angularly adjusted position.

Referring now, additionally, to FIGS. 3 to 7, inclusive, each insert has a cylindrical outer side 44, a flat circular bottom face 46, and a circular flat working face 48, which, when the insert is installed within its respective socket 30, lies in a plane parallel to and flush with the working face 14 of the wheel body 12. The working face 48 is formed with a relatively shallow diametrically disposed groove 50 therein to receive the abrasive segment 42.

The abrading element 42 may assume various noncircular shapes, but in the form shown in FIGS. 1 to 7, inclusive, they are of elongated, generally rectangular design and have planar abrading surfaces 52 which lie in a plane parallel to and slightly outwards of the working face 48 of the wheel body. The ends of each segment 42 may be rounded as shown at 54 (see FIG. 5). The base portion of the element 42 seats snugly within its groove 50 and is secured therein by a suitable bonding operation such as by the use of solder or an appropriate adhesive, for example, one of the epoxy resins. Each abrasive segment 42 may be in the form of a metallic matrix having distributed throughout the same a quantity of crushed or fragmented diamonds.

In order to seal the bottom regions of the sockets 30 from sludge seepage and the fine silt-like material carried thereby, particularly where glass grinding operations are concerned, each insert 40 is formed with an annular groove 60 in the upper regions of the cylindrical side 44 thereof for reception therein of a conventional O-ring 58 (see FIG. 2) which preferably is formed of rubber or other elastomeric material. The outer peripheral portions of the O-rings 58 engage the cylindrical side walls 32 of the sockets 30 frictionally with the result that the rings not only serve to prevent sludge seepage into the sockets, but also serve to hold the inserts temporarily in place in connection with angular or rotative adjustment thereof.

In order adjustably to lock the various segment-carrying inserts 40 in selected positions of circumferential adjustment to orient the axes of the segments 42 in a desired manner, each insert of the two marginal rows has associated therewith an individual locking screw 62. Each locking screw 62 extends through a threaded bore 64 in the metal of the body 12 to the socket 30 in which the insert is mounted, and, in addition, each locking screw projects into an annular V-shaped groove 66 which is formed in the cylindrical side 44 of the insert in the lower regions thereof. The annular groove 66 (FIGS. 3, 4 and 6) is formed with a frusto conical, lower upwardly facing, side wall 68 and an upper, planar, radial, downwardly facing, side wall 70. The locking screw 62 is provided with a pointed or conical end 72 which makes contact with the frusto conical side wall 68, as best seen in FIG. 6. The various locking screws 62 are preferably of the Allen-head type and the screws for the outer circular row of inserts 40 are accessible through the outer side face 16 of the wheel body 12 and are arranged tangentially with respect to their respective inserts, while the locking screws 62 for the inner circular row of inserts are accessible through the inner side face 18 and are radially arranged with respect to their associated inserts. Where a medial circular row of segment-carrying inserts is provided, the locking screws therefor may extend through the nearest side face 16 or 18, as the case may be, if there are no intervening sockets to interfere therewith, or alternatively, the locking screws may project through inclined bores which are accessible through the working face 14 of the wheel body 12. Such a locking screw arrangement is shown in FIG. 7 wherein the set screw 61 for one of the inserts 40 of the medial row of inserts extends through an inclined bore 63 and has a blunt end 65 which engages the frusto conical side wall 68 of the insert 40 and forces the insert as a whole against the bottom wall 34 of the socket 30 and also against the far side of the cylindrical wall 32.

When the locking screws 61 and 62 are tightened against the frusto-conical side walls 68, the frictional and camming relationship existing between the screws and inserts is such as to force the bottom faces 46 of the inserts firmly against the bottom walls 34 of the sockets 30, while at the same time exerting such pressure on the surfaces 68 as to force the inserts against the cylindrical walls 32.

Referring now to FIGS. 1, 8 and 9, there are shown therein different arrangements of the inserts 30. Insofar as the orientation of the segments 42 is concerned, the insert patterns selected for illustration herein are merely exemplary of typical patterns which are commonly resorted to in connection with grinding wheels having fixed abrasive segments. In FIG. 1, the axes of all of the segments 42 extend in a generally circumferential direction so that these segments may be said to be in circumferential alignment. In FIG. 7, the axes of the segments 42 extend radially of the grinding wheel. In FIG. 8, the axes of the segments extend at an in-between angle which is such that the leading sides of the segments tend to cam or scoop the coolant sludge radially outwardly of the wheel. The segments may be otherwise angularly adjusted in their respective sockets so that they collectively bear a predetermined directional relationship to any given wheel diameter or they may be individually adjusted, the purpose of the adjustments being, as previously stated, to facilitate empirical considerations which must necessarily be borne in mind in the production of the attainment of the best possible geometrical disposition of the segments with respect to the working face of the grinding wheel. It is, of course, not necessary that an insert be disposed in each of the various sockets inasmuch as in certain instances better results will be attained where, for example, alternate inserts in each row thereof are omitted. By angularly or rotatively adjusting the inserts 40 in their respective sockets 30 in one direction or the other, the abrasive segments 42 may be positioned so as to present a greater or less width of abrasive particles in their abrading or grinding faces 52 to the circular path in which they are rotated in connection with drive of the wheel body 12. When the segments are positioned circumferentially of the wheel body as shown in FIG. 1, the width of the abrasive particles which are in the grinding surfaces 52 and are presented to the circular path in which the segments are rotated in connection with drive of the wheel body is a minimum. When the segments 42 are positioned as shown in FIG. 2, the width of the abrasive particles which are in the grinding surfaces 52 and are presented in the circular path in which the segments are rotated in connection with drive of the wheel body is a minimum. When the abrasive segments 42 are positioned radially with respect to the wheel body 12 as shown in FIG. 8, the width of the abrasive particles which are in the grinding surfaces 52 and are presented in the circular path in which the segments are rotated is a maximum. When the abrasive segments are positioned in an in-between position as shown in FIG. 9, the width of the abrasive particles which are in the grinding surfaces 52 and are presented to the circular path of rotation of the segments is substantially half-way between minimum and maximum widths.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit or scope of the invention. Only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

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

1. A rotary grinding wheel comprising a wheel body adapted in connection with use of the wheel to be driven in one direction about its axis and having on one side thereof an annular face in concentric relation with said axis, an annular series of spaced apart mounting inserts positioned adjacent to, and in concentric relation with, the face of the wheel body, mounted with respect to the wheel body so that they are individually and freely rotatable about centrally-disposed axes at right angles to said face and without axial displacement, and provided with substantially flat, coplanar, outer working faces, elongated, block-like, abrasive segments extending substantially diametrically across, and fixedly connected to, the outer working faces of the mounting inserts, formed of abrasive particles distributed substantially uniformly throughout hard matrices, having substantially flat and coplanar, outer grinding surfaces, and adapted when oriented and in connection with similar angular adjustment of the mounting inserts about their respective axes and in one direction or the other to be positioned so as to present a greater or less width of abrasive particles in their outer grinding surfaces to the circular path in which they are rotated in connection with drive of the wheel body, and releasable means for holding the inserts in connected relation with the wheel body and also securing said inserts fixedly in their various positions of angular adjustment.

2. A rotary grinding wheel as set forth in claim 1 and



wherein the outer working faces of the mounting inserts have formed therein straight, shallow, diametric grooves of rectangular cross section, and the inner portions of the abrasive segments fit snugly within the grooves and are thereby interlocked against lateral displacement with respect to the inserts.

3. A rotary grinding wheel as set forth in claim 1 and wherein the wheel body embodies an annular series of spaced apart, cylindrical sockets which correspond in number to, and are associated respectively with, the mounting inserts, said sockets being defined by cylindrical side walls and circular bottom walls, and have open outer ends extending through the annular face of the wheel body, and wherein the said mounting inserts are cylindrical, fit snugly within the sockets, and are freely rotatable with respect to the sockets upon release of the means for holding the inserts in connected relation with the wheel body and also securing said inserts fixedly in their positions of angular adjustment.

4. A rotary grinding wheel as set forth in claim 3 and wherein the outer working faces of the mounting inserts are in parallel relation and substantially flush with the annular face of the wheel body.

5. A rotary grinding wheel as set forth in claim 3 and wherein the peripheral portions of the cylindrical mounting inserts that are disposed immediately inwards of the open outer ends of the sockets are provided with annular grooves, and such grooves have mounted therein elastomeric O-rings, the outer peripheral portions of which engage frictionally the adjacent portions of the cylindrical side walls of the sockets.

6. A grinding wheel as set forth in claim 3 and wherein certain portions of the cylindrical mounting inserts that are disposed within the sockets in the wheel body are provided with annular V-shaped grooves, parts of which are defined by frusto conical walls which face in the direction of the open outer ends of the sockets, and the releasable means for holding the inserts in connected relation with the wheel body and also securing the inserts fixedly in their various positions of angular adjustment comprise screws which are mounted in screw-threaded bores which are formed in the wheel body, are laterally disposed with respect to the sockets, and have the inner ends thereof extending through the cylindrical side walls of the sockets at locations opposite to the annular V-shaped grooves in the mounting inserts, said screws when in their operative position having the inner ends thereof in engagement with said frusto conical walls.

7. A grinding wheel as set forth in claim 6 and wherein the screws are so arranged and constructed that, when they are tightened, the inner ends thereof coact with the frusto conical surfaces of the insert numbers in such manner as to cam the insert members inwards to the end that their inner ends will be firmly clamped against the circular bottom walls of the socket.


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