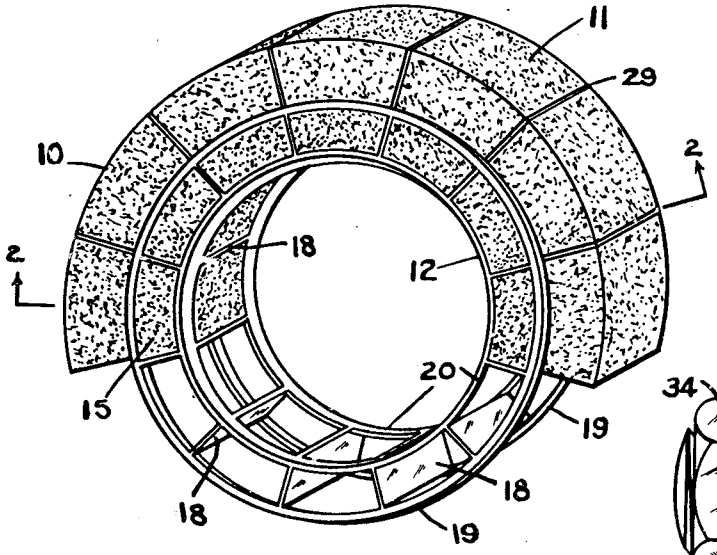
Oct. 30, 1934. T. LARSSON 1,979,074

SEGMENTAL GRINDING WHEEL

Original Filed Sept. 4, 1926

Fig. 1



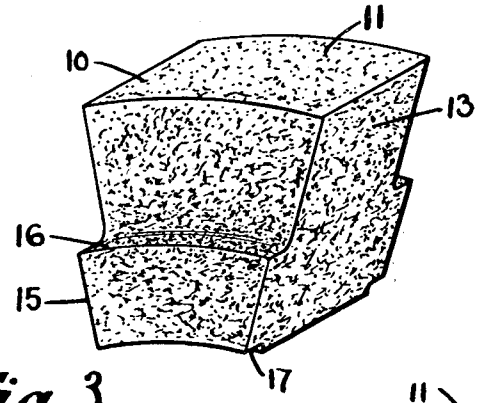


Fig. 3

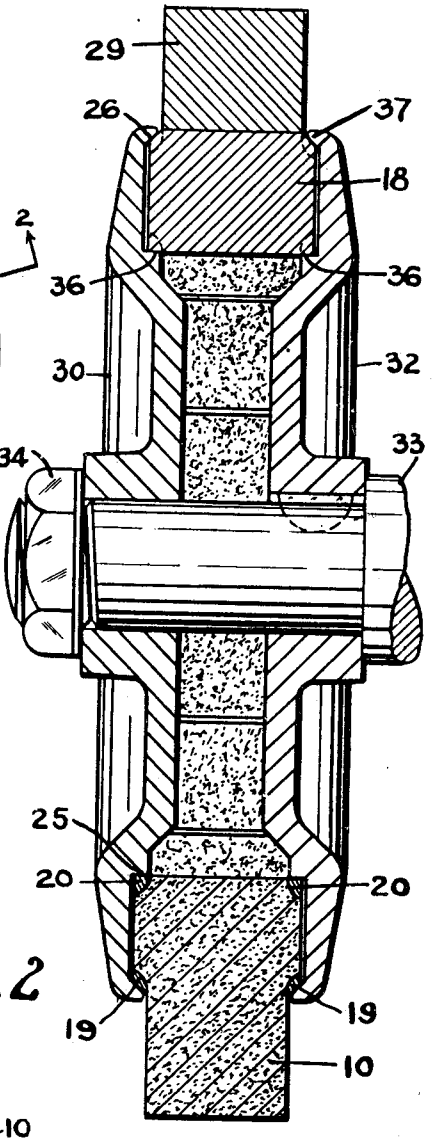


Fig. 2

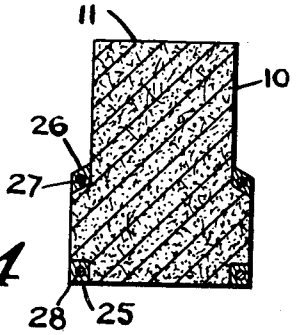


Fig. 4

Witnesses

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UNITED STATES PATENT OFFICE

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SEGMENTAL GRINDING WHEEL

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Continuation of application Serial No. 133,531, September 4, 1926. This application October 8, 1927, Serial No. 224,989. In Canada August 29, 1927

18 Claims. (Cl. 51—207)

This invention relates to abrasive wheels and more particularly to a wheel composed of abrasive segments united into a unitary rigid structure, and to a method of making the same.

The modern abrasive wheel is ordinarily made by bonding abrasive grains, such as silicon carbide or crystalline alumina, into a structure of desired shape. The bond may be any one of various types, such as rubber, sodium silicate, or resinous materials, but more common are ceramic materials vitrified to a glassy or porcelanic condition by a suitable firing operation. The efficiency of a grinding wheel is materially improved by increasing its surface speed, but owing to the fragile nature of the available bonds, the size and the rate of rotation of the wheel is seriously limited. For many grinding operations it is desirable to use a wheel of a relatively soft grade, but such a wheel ordinarily has only a small amount of bond to hold the grains in place, and the wheel has but little cohesive strength, so that it cannot effectively withstand the disruptive forces set up by grinding at a high rotative speed. Furthermore, in the manufacture of a large wheel made of ceramic bonded abrasive grains, there is danger of the wheel being broken during the moulding and firing operations, owing to the friable and fragile nature of the moulded article and to the difficulties of firing the body uniformly and preventing the development of a strained condition in the bond.

In accordance with my invention, a wheel that may be rotated rapidly and yet safely may be made of small segments manufactured separately and then assembled and united into a unitary wheel structure, and such a wheel may be so supported on a rapidly rotated mount that the tendency for the wheel to be disrupted by centrifugal force is effectively resisted.

It is accordingly one object of my invention to provide a grinding wheel made of separately fashioned abrasive segments which are fastened together and may be mounted as a unit on a grinding wheel spindle, and particularly to provide such a wheel which may be made in diverse grades, shapes and sizes and is capable of giving a long life of efficient service when rotated at a high speed.

Further objects are to provide a rotative mount for an abrasive wheel which aids materially in strengthening the wheel against disruption by centrifugal force, and in particular to provide a segmental abrasive body having sufficient strength for handling and shipment and a supporting structure therefor which supplements the bond strength of the segments and holds them effectively in place during the grinding operation.

A further object is to provide an efficient method of making a unitary abrasive wheel from a number of separately fashioned segments.

With these and other objects in view, as will be apparent to one skilled in the art, my invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

One embodiment of my invention is a grinding wheel of a desired size made of separately fashioned abrasive segments which may be assembled to form a grinding surface. These are united into an integral wheel structure by a cementitious bonding material, such as a low melting metal, which is capable of holding the segments in position, either for shipment or for grinding usage, thereby forming an abrasive body which may be transported independently as a unit and removably mounted as such on a suitable support. The adhesive strength of the cementitious medium, as well as the coherence of the bond which unites the abrasive grains, may be supplemented by a reenforcing structure which engages a peripheral surface of the wheel and serves to resist any centrifugal force set up in the inner portion of the wheel.

It is desirable that the filler or cementitious material between the grinding portions of the segments wear away as fast as and preferably at the same rate as the abrasive segments wear, and this material may be varied depending on the type of grinding operation for which the wheel is intended. As an example of a filler which will wear away at substantially the same rate as the abrasive wears away for the average metal grinding operation, a mixture of sulfur and carbonaceous material, known as lavasul, may be employed. I may use a strong bonding medium, such as Babbitt metal, in the inner spaces of the wheel to hold the segments securely in place, and a softer, more wearable filler in the crevices between the segments adjacent to the grinding surface.

The wheel strength may be materially increased by so constructing the rotatable wheel mount that it clamps against a peripheral surface on the wheel and preferably against a shoe of suitable material, such as metal, which will make firm contact throughout an extensive area with the clamping support as well as the abrasive body. If the wheel is intended to grind

on its periphery, it is preferably provided with clamping faces on both sides thereof which have shoes of suitable material and shape to form surfaces against which clamping supports may engage. Furthermore the abrasive segments may be so shaped and constructed that the thickness of the abrasive material beneath the clamping support is substantially equal to the transverse thickness so that resistance to shearing or cracking is substantially the same in every direction.

Referring more particularly to the drawing which illustrates a grinding wheel adapted to grind on its peripheral face and in which like reference numerals indicate like parts;

Figure 1 is a perspective view of an abrasive wheel, partly broken away to show the bonding structure which holds the segments in place;

Fig. 2 is an enlarged sectional view on the line 2—2 of Fig. 1;

Fig. 3 is a perspective view of one of the segments; and

Fig. 4 is a sectional view of a modified form of segment which has reinforcing members embedded in the shoes.

As illustrated in the drawing, a unitary segmental wheel may comprise a number of abrasive segments 10 made up of abrasive grains, such as crystalline alumina or silicon carbide, united in accordance with standard methods by a suitable bonding material, such as a vitrified ceramic bond, the structure, porosity and grade of hardness of the bonded mass varying in accordance with the grinding characteristics required. These segments are made of such sizes and shapes as to be capable of assembly in the required form of grinding wheel and to provide a suitable grinding surface. If the wheel is to grind on its periphery, the assembled segments are shaped as illustrated to form an annulus which has a cylindrical grinding surface 11 and an internal peripheral surface 12. In order to hold the segments rigidly in place, I provide a cementitious material which is capable of adhering to the spaced, radial, side faces 13 of the segments and entering their surface pores, and thereby uniting the segment into a unitary structure. Of the various cementitious materials which may be employed for this purpose, I preferably utilize a low melting metal, such as a Babbitt alloy of lead, tin and antimony, which may be melted and flowed while hot into the interstices between the assembled segments. This cementing filler may serve as the sole medium which units the segments into a rigid integral body; and it may be supplemented by a reinforcing structure, such as a bond, which surrounds a peripheral surface or engages a shoulder of the assembled segments, and preferably one on each side thereof, and thereby resists breakage by the disruptive forces met in the grinding operation, as well as rough handling incident to manufacture and transportation.

In order to carry on a grinding operation, the unitary body of assembled segments is mounted on a rotary support, and such a support may comprise members shaped and arranged to engage supporting and clamping surfaces on the assembled segments. Proper contact may be had between the supporting members and the abrasive body throughout an extensive surface by introducing shoes between the clamping members and the abrasive. These shoes may be made of suitable material which is capable of absorbing or distributing the strains set up in mounting and rotating the wheel; and they may be inserted as desired between the abrasive body and its support, but I prefer to form them on the clamping and supporting surfaces of the abrasive body so that they are substantially integral therewith. This is easily accomplished by casting or otherwise forming a suitable material, such as a low melting metal, in place on the proper portions of the segments. In the form illustrated, the shoes and the cementitious material between the segments are made of the same substance and may be formed by a single casting operation.

The abrasive annulus formed of the assembled segments is provided with a suitably arranged clamping shoulder adapted to be engaged by the clamping members of the support, and for this purpose I prefer to form a shoulder on the side of the wheel, and preferably both sides, which is located at a distance from the grinding surface of the wheel and is therefore out of the way of the grinding operation. The abrasive segments should fit securely and properly against the supporting surface of the rotatable mount, and it is therefore desirable that a shoe or other suitable medium be interposed between the inner peripheral surface of the abrasive body and its support to absorb and distribute the clamping and rotational strains.

In the form illustrated, the shoulders are on a raised projection 15 on each side of the abrasive segment, these projections providing an outer peripheral shoulder 16 and an inner peripheral shoulder 17 on each side thereof. The shoulder 16 is preferably located at some distance from the inner peripheral shoulder 17 so as to leave a large amount of abrasive material between the clamping shoulders 16 and 17; and the distance between these shoulders is preferably so proportioned relative to the thickness of the segment that the segment is as likely to break transversely between the two opposite shoulders 16 and 17, thereby insuring the maximum strength beneath the clamping shoulders to support the abrasive segment in place under a high rate of rotation and the strains of grinding.

The segments of the shape shown in Fig. 3 are assembled as an annulus with their faces 13 slightly spaced apart, and Babbitt metal is flowed or otherwise placed in the interstices therebetween, forming webs 18 of metal which make intimate contact with the segments and unite them into an integral body. The clamping shoes 19 and 20 on the shoulders 16 and 17 may be formed at the same time by the provision of suitable casting molds, or if desired they may be separately formed on the individual segments before assembly. As shown, the webs 18 and the shoes 19 and 20 are integral parts of a skeleton frame work, so arranged that the shoes surround the peripheral shoulders 16 and 17. The shoe 20 formed on the surface 17 has a substantially cylindrical inner surface 25 which is adapted to engage a corresponding surface on a support, while the shoe 19 preferably has a beveled face 26 which is shaped as the frustum of a cone so that a complementally shaped clamping member may have a wedge-like action on this surface when drawn into place, and thereby compressively hold the segment between the two clamping shoes. If it is desired to utilize a reinforcing member, strengthening wires 27 and 28, as shown in Fig. 4, may be properly positioned in the mold so that they

will lie embedded in the shoes and form strong bands capable of holding the segments securely in place as well as strengthen the wheel.

As shown, the metal frame work does not extend outwardly beyond the shoe 19, thereby leaving open crevices between the grinding portions of the segments. These crevices are preferably filled with a substance 29 capable of wearing away as the abrasive body is ground away and of keeping the crevices filled substantially to the grinding surface. A suitable filler for this purpose is a mixture of about 60% of sulfur with 40% of pulverized coke, known as lavasul, but it will be understood that other materials, such as those commonly employed as bonds and cements in this art, may be used. This filler unites intimately with the abrasive segments and aids as a bond in strengthening the wheel and particularly in preventing injury to the outer corners and edges of the segments.

In the manufacture of such a wheel, the segments of bonded abrasive grains, previously shaped to form an annulus of the desired dimensions, may be suitably assembled in their final arrangement, independent of the grinding wheel support, around a central, upwardly extending, cylindrical portion of a specially constructed plate or table. The segments are slightly spaced to provide the crevices within which the cementitious medium may be poured. Suitably shaped forms are placed around and between the segments to form the shoes and to limit the flow of metal in the radial spaces, so as to leave the outer portions of the crevices for the softer filler. The segments may be held in proper place by a band of metal placed around them, and covered by a plate provided with pouring holes arranged to come directly over the crevices between the segments. Thereafter, molten Babbitt metal is poured through the holes in the cover plate to fill the unobstructed portions of the crevices between the segments as well as the annular spaces left for the shoes. This material flows into the surface pores of the segments and hardens, and thereby bonds the segments integrally in a rigid and secure manner. When the molten metal has cooled and set, the outer unfilled spaces between the segments may be filled with a composition capable of hardening in place, such as a mixture of sulfur and carbonaceous material known as lavasul, after which the wheel is ready for use. It will be understood that a single cementitious medium may be used alone to fill the crevices and form the webs 18. Also, they may be formed separately on the individual segments, thereby permitting the segments to be shipped as desired and easily assembled at the place of use, in which case it is merely necessary to provide a suitable bonding cement to unite them into an integral wheel structure.

A grinding wheel of the type described may not be sufficiently strong to stand the high rate of speed desired for its use, although it is strong enough for transportation and storage and the ordinary handling operations incident to manufacture. A further feature of my invention accordingly comprises a grinding wheel support which is so constructed and arranged that it will carry an abrasive wheel and add materially to its bond strength. To this end, I utilize two relatively adjustable members having a supporting surface adapted to engage an inner surface of the wheel and a clamping surface adapted to engage an outer clamping face upon the abrasive annulus, so that upon drawing the two clamping and supporting members together, the abrasive body will be securely held in position for grinding.

A simplified form of clamping and supporting member, as illustrated, comprises two clamping plates 30 and 32 adapted to be suitably mounted on a grinding wheel spindle 33. The plate 32 may be keyed to the spindle and the plate 30 slidably mounted on the reduced end of the shaft and secured in position by means of a nut 34. The two plates are each provided with a shoulder 36 having an external peripheral surface adapted to engage and support the inner surfaces 25 of the shoe 20. Each plate likewise has an inwardly projecting rim 37 near its outer edge which has a steeply beveled surface adapted to slidably engage the frusto-conically shaped surface of the shoe 19. It will therefore be seen that upon drawing the two plates towards each other, as by means of bolts therebetween or the nut 34, the beveled surfaces on the rims 37 will slide on the shoes 19 and compressively clamp the segments in position against the supporting shoulders 36. Whatever the construction of the abrasive annulus, this form of mount will hold the abrasive body securely in place against the disruptive action of centrifugal force.

Since the clamping plates confine a considerable proportion of the wheel volume therebetween, it will be seen that the shoes 19 and 20 serve largely as bearings for the clamping surfaces on the plates and that the rings 19 and 20 of the frame structure shown in Fig. 1 need have no great strength for many types of wheel. In case the bonding webs 18 may need reinforcement, then it is desirable that the rings 19 and 20 be so constructed that they will aid in holding the segments together during the handling operations incident to manufacture and transportation before the wheel is mounted on a grinding machine spindle. These shoes also locate the wheel correctly on the mount, hence they should be accurately shaped. Owing to the fact that the clamping rims 37 engage the wheel close to its grinding portion, a considerable proportion of the abrasive body is confined between the plates, and the dangers incident to breakage are minimized.

In accordance with my invention, I have provided an abrasive wheel made up of segments which, for the larger wheel sizes, may be manufactured inexpensively compared with the cost of making the usual form of an integral monolithic wheel. These may be easily assembled and cemented together either before or after shipment to the point of use. When mounted on the rotatable support, the wheel is further reinforced by the strong metal plates employed for this purpose. Such a wheel may be rotated at an extremely high speed, as is desirable since it has been found that the amount of wheel wear is approximately constant at the various speeds of rotation for the same amount of material removed from the object being ground. Thus, by increasing the speed of rotation of the grinding wheel, the cost of grinding a given article is materially reduced.

This case is a continuation of my application Serial Number 133,531, filed September 4, 1926.

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

1. The method of making a grinding wheel

which comprises assembling a plurality of bonded abrasive segments in spaced relation in the form of a wheel, and casting a cementitious material around a peripheral surface of and between the segments in such a manner as to form a reinforcing structure for supporting and holding the segments rigidly in position.

2. The method of making a grinding wheel which comprises assembling a plurality of bonded abrasive segments in spaced relation in the form of a wheel, and forming a cementitious reinforcing structure upon a side of the segments having a frusto-conical surface of accurate dimensions to fit a flange for mounting upon a grinding machine.

3. An abrasive wheel comprising a row of spaced abrasive segments arranged independently of any support as an annulus having parallel side faces, an inner supporting surface and a peripheral grinding surface, a cementitious material between the segments which unites them into an integral wheel structure, a shoulder on each outer side of the wheel located at a considerable distance from the inner surface of the annulus and close to that portion of the wheel which is normally intended to be used in the grinding operation, and a shoe integral with each shoulder which has a bevelled clamping surface arranged to receive the pressure of a mating clamping member and transmit it to the abrasive body.

4. A grinding wheel comprising a row of ceramic bonded abrasive segments arranged as an annulus, a metal cast between the segments and uniting them into an integral body which is independent of the wheel support, a shoe cast on the inner surface of the annulus and forming a seat therefor, and a shoe cast on each outer side of each segment which has a beveled shoulder for engagement with a rotatable clamping member on a wheel support.

5. An abrasive segment comprising a body of bonded abrasive grains shaped to have an outer convex surface, an inner concave surface, two radially converging faces and two sides, each side having a shoulder, a clamping shoe molded on each shoulder and a seating shoe molded on the inner concave surface.

6. An abrasive wheel comprising a plurality of segments of bonded abrasive grains arranged independently of a support as an abrasive annulus, and means including a tough cementitious bonding material in the inner portions of the crevices between the segments and a friable cementitious filler in the outer portions of the crevices capable of wearing away at approximately the same rate as does the abrasive material during the grinding operations which serve independently of any supporting member to unite the segments into an integral wheel structure capable of being transported and mounted as a unit on a rotary support.

7. A grinding wheel comprising bonded abrasive segments arranged as an annulus, a cementitious material in the spaces between the segments which unites them into an integral body independently of the wheel support, a shoe integral with the annulus and forming an inner peripheral supporting surface, each segment having clamping shoulders on its opposite outer faces, and a shoe integral with each shoulder and having a beveled surface for engagement by a correspondingly shaped member on a rotatable wheel support.

8. An abrasive wheel comprising a plurality of abrasive segments arranged as an annulus which has a peripheral grinding surface, an inner supporting surface and a peripheral shoulder on each of its outer sides, a cementitious filler in the interstices between the segments, and clamping and seating shoes on said inner surface and shoulders which are integral with said cementitious material, said shoes on the peripheral shoulders forming continuous rings encircling and strengthening the wheel.

9. A grinding wheel comprising a plurality of abrasive segments arranged as an annulus, each segment having a shoulder on each of its opposite outer sides, beveled clamping shoes rigidly fixed on the shoulders, a shoe integral with the inner face of the annulus and forming a peripheral seat, a cementitious material in the crevices between the segments uniting them into an integral body, and removable, reinforcing and supporting members providing a support for said seat and having clamping members wedgingly and compressively engaging said seat and beveled shoes and serving to resist the centrifugal force when the wheel is rotated at a high speed.

10. A grinding wheel comprising a plurality of abrasive segments shaped and assembled to form an abrasive annulus having a grinding face and a seating face, each segment having clamping shoulders on opposite sides thereof, a cementitious filler cast in the interstices between the segments and rings cast on said clamping shoulders and against said seating face which are integral with said filler and cooperate to unite the segments into a rigid wheel structure, said rings serving as clamping and seating shoes for mounting the wheel on a support.

11. An abrasive wheel comprising a plurality of spaced segments of bonded abrasive grains arranged independently of their rotative support as an annulus which has a peripheral grinding surface, parallel side faces and an inner seating surface, a cementitious filling material in the crevices between the segments which supports them laterally and aids in holding the wheel structure together, shoulders on the outer sides of each segment, a shoe integral with each shoulder which has a bevelled clamping surface thereon, removable supporting plates on each side of the wheel having supporting surfaces which mate with the seating surface and the bevelled shoes on the annulus, and means for clamping the plates against the annulus so that they wedgingly engage it and resist disruption thereof when rotated at high speed.

12. An abrasive wheel comprising a plurality of spaced abrasive segments arranged independently of their rotative support as an annulus having a peripheral grinding face, parallel side faces and an inner seating surface, a filler in the crevices between the segments, the annulus having shoulders on its opposite side faces, means comprising a ring-shaped shoe rigidly mounted on each shoulder of the annulus which reinforces the wheel structure, said shoes having bevelled clamping surfaces, and clamping plates having mating surfaces wedgingly engaging the seating and bevelled surfaces of the annulus which support the same and resist disruption of the wheel when rotated at high speed.

13. An abrasive wheel comprising a plurality of spaced abrasive segments arranged independently of their rotative support as an annulus having a peripheral abrasive face, side faces, an inner seating surface shaped for engagement

with a support and shoulders on its opposite sides, a reinforcing ring surrounding each of the peripheral shoulders, cementitious material on each shoulder which embeds the ring and holds it rigidly in position, and a cementitious filler in the crevices between the segments which cooperates with the rings to form an integral wheel structure, the cementitious material on each side of the wheel constituting a shoe and having a bevelled clamping surface for engagement with a supporting plate which mates with said seating and bevelled surfaces, whereby the wheel may be wedgingly supported when rotated during a grinding operation.

14. An abrasive wheel comprising a plurality of spaced bonded abrasive segments arranged as an annulus independently of their rotative support and shaped to provide a peripheral grinding face, an inner hole surface and shoulders on the outer side faces of each of the segments, a filling material in the crevices between the segments which aids in holding them in position during a grinding operation, a seating shoe rigidly fixed on the hole surface of each segment, and a clamping shoe integral with each of the shoulders of each segment which has a bevelled clamping face, whereby the abrasive annulus may be wedgingly supported and the segments held in position by and between two clamping members engaging said shoes.

15. An abrasive wheel comprising a plurality of bonded abrasive segments arranged independently of their rotative support as an annulus having a peripheral abrasive face, parallel side faces and an inner seating surface, each segment having a short shoulder for a shoe on each of its outer sides which is located near but not on the grinding portion of the annulus, a clamping shoe which is fixed rigidly on each shoulder and has a bevelled clamping surface, and a cementitious filler between the segments which is capable of keeping the crevices filled and of protecting the corners of the segments during a grinding operation, said inner seating surface and shoes being shaped for wedging engagement by opposed supporting plates which thereby resist disruption of the wheel when rotated at high speed.

16. A grinding wheel comprising a row of spaced abrasive segments arranged as an annulus independently of their rotative support and shaped to form a peripheral abrasive face, parallel side faces, and an inner peripheral surface, shoulders on each side face which are spaced at a considerable distance from the hole face and are shaped to support clamping shoes, a cementitious filling material between the segments which is capable of wearing away, within the grinding portion of the wheel, at substantially the same rate as does the abrasive and of keeping the crevices filled and the corners of the segments protected during a grinding operation, supporting shoes on the inner peripheral surfaces of the segments, and bevelled clamping shoes on said shoulders, said shoes being shaped to mate with and be wedgingly mounted on corresponding surfaces on opposed clamping plates arranged to support the wheel.

17. An abrasive wheel comprising a plurality of bonded abrasive segments arranged independently of their rotative support as an annulus which has a peripheral abrasive face, side faces, an inner shoe retaining surface and a peripheral shoulder on each of its sides, a reinforcing ring rigidly secured on each shoulder, a cementitious filler between the segments which is capable of keeping the crevices filled and of protecting the corners of the segments during a grinding operation, said filler and rings serving to unite the segments into a rigid wheel structure which may be transported independently of its rotative support, and a supporting shoe on said inner surface, said wheel having a short bevelled surface on each side thereof, whereby said shoe and bevelled surface may be wedgingly mounted on the mating surfaces of a clamping plate which thereby resist disruption of the wheel when rotated at high speed.

18. An abrasive wheel comprising a plurality of bonded abrasive segments arranged independently of their rotative support as an annulus having a peripheral abrasive face, an inner hole face, side faces and a shoulder on each side thereof, a reinforcing ring surrounding each of said shoulders, a cementitious filler in the crevices between the segments which aids the rings in uniting the segments as a rigid wheel structure, a supporting shoe integral with the hole face and shoes having bevelled clamping faces on the exposed sides of the segments, the shoes being so shaped that the wheel may be wedgingly mounted between two opposed clamping plates and thereby reinforced during use.

THURE LARSSON.