Dec. 27, 1966 P. E. SCHAFFNER 3,294,502

METHOD FOR PRODUCING POLISHING WHEEL

Original Filed April 29, 1959

Fig.1

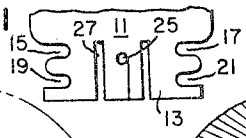


Fig.1a

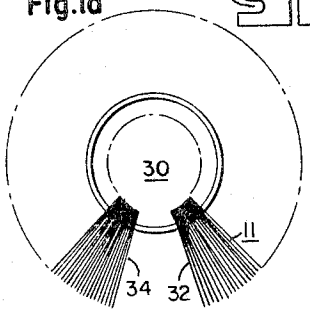


Fig.3

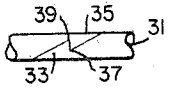


Fig.7

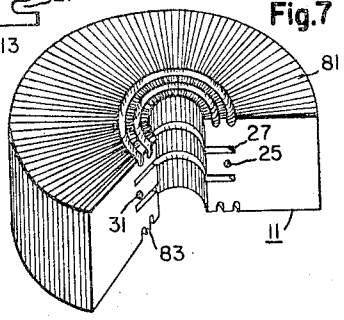


Fig.8

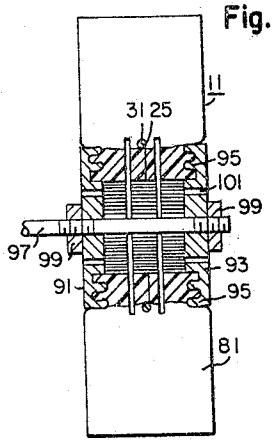


Fig.2

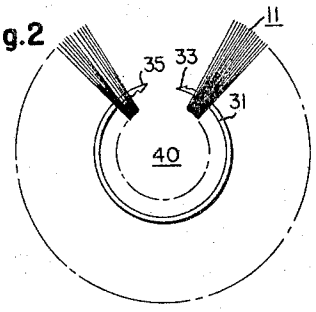


Fig.10

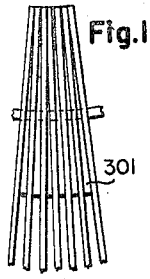


Fig.6

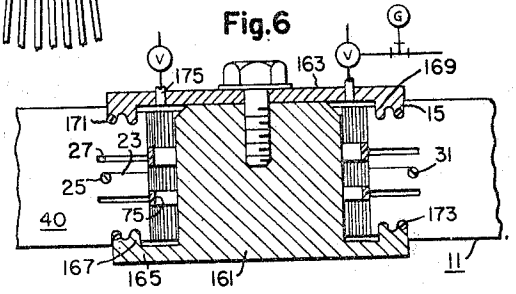
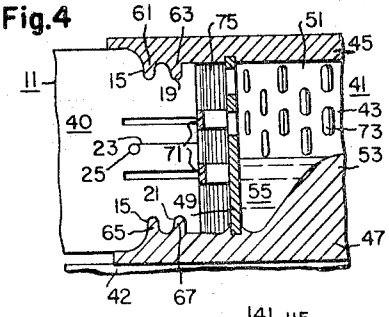


Fig.4



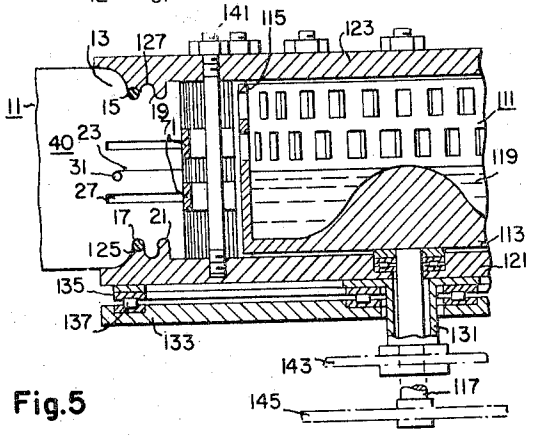


Fig.5

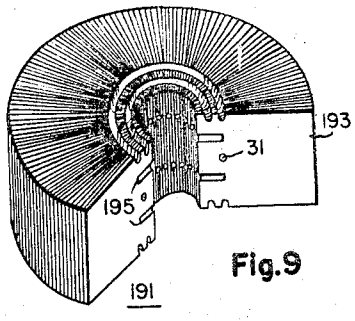


Fig.9

United States Patent Office 3,294,502 Patented Dec. 27, 1966

3,294,502

METHOD FOR PRODUCING POLISHING WHEEL

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Original application Apr. 29, 1959, Ser. No. 809,647, now Patent No. 3,206,894, dated Sept. 21, 1965. Divided and this application May 9, 1962, Ser. No. 193,446
7 Claims. (Cl. 51—293)

This application is a division of application Serial No. 809,647, filed April 29, 1959 and now U.S. Patent No. 3,206,894 to Paul E. Schaffner for Polishing Wheel and Method for Producing Such Wheel.

This invention relates to the polishing or buffing art and has particular relationship to polishing wheels. The expression "polishing wheel" is used in this application in its general sense and is meant to include within its scope buffing and finishing as well as polishing wheels.

This invention in its specific aspects concerns itself with polishing wheels composed a plurality of flaps of abrasive material. Usually such flaps are abrasive on one side and smooth on the other. Such wheels are in the form of an annulus, usually (but not necessarily), with the abrasive surface of each flap contiguous to a smooth surface of the adjacent flap and with the radially inner ends of the flaps bonded together by an adhesive between the surfaces of the flaps.

The making of such wheels, in accordance with the teachings of the prior art, has disadvantages. The bonding of the inner surfaces presents a serious problem.

In accordance with the teachings of the prior art, the annulus is provided with flanges, one of which has an opening in the center and the adhesive is injected through this opening while the annulus is rotated at a substantial speed about a horizontal axis. The adhesive is injected between the flaps by centrigual force. The injection of the adhesive presents difficulties. In addition the hubs of wheels of this type have been found to be fragile and to crack during shipment.

There are disadvantages in the prior art wheels themselves. In use the wheels are rotated at a high speed, the abrasive surfaces of the flaps successively engaging the work. Excessive heat develops during such use and the flaps are charred materially shortening the life of the wheels. In addition, the ends of the flaps fray substantially.

It is then a specific object of this invention to provide a method for making polishing wheels composed of abrasive flaps which shall not have the disadvantages of prior art methods.

More specifically stated, it is an object of this invention to provide a low-cost readily usable method for making polishing wheels of abrasive flaps, the hubs of which shall be resistant to fracture.

A further specific object of this invention is to provide a low-cost readily usable method of bonding the surfaces of the radially inner ends of the flaps in the making of a polishing wheel or flaps formed into an annulus and particularly in the making of a wheel formed of abrasive flaps.

Still another specific object of this invention is to provide a low-cost method of forming a fracture-resistant hub of a polishing wheel in the form of an annulus of flaps and particularly of abrasive flaps.

It is an object of this invention to provide a novel method of producing a polishing wheel in the form of an annulus of flaps having important advantages in the making of wheels with abrasive flaps but also applicable to wheels in which the flaps are of nonabrasive material, and it is another object of this invention to provide such a wheel.

This invention, in one of its specific aspects, arises from the realization that in the practice of the prior art method the distribution of adhesive over the surfaces of the radially inner edges of the flaps of the annulus is not uniform because of the manner in which the annulus is rotated to inject the adhesive between these surfaces. This disadvantage and the difficulties in applying the adhesive are both overcome in accordance with this invention by confining the liquid adhesive in a horziontal pool within the annulus and then rotating the annulus and adhesive about a vertical axis. During this rotation the adhesive is injected uniformly between the flaps. It has been found that highly effective penetration can be produced even where the flaps are tightly packed. The speed of rotation and the viscosity of the adhesive are correlated so that the adhesive is injected only over a suitable distance from the inner periphery of the annulus towards the outer periphery of the annulus and not beyond this distance. After the adhesive is injected it is cured, and it has been found that a wheel with a strong fracture-resistant annulus results.

The annulus and adhesive may be rotated together. But in accordance with an important specific aspect of this invention the annulus and adhesive are rotated separately at different speeds. The relative rotation of the annulus and adhesive assures uniform distribution of the adhesive over the radially inner ends of the annulus and the uniform penetration of the adhesive between the surfaces contiguous to these ends.

The fracture-resistance is further increased by mounting the flaps on a resilient ring which serves not only to facilitate the formation of the flaps into an annulus but also in strengthening the hub. In accordance with one aspect of this invention the ring may be solid. During the formation of the annulus the ring is inserted in the flaps through slits extending from the radially inner ends engaging an opening at the ends of the slits. When the flaps extend around substantially the whole ring, the adjacent flaps at one point of the ring are separated and clamped under substantial pressure and additional flaps are inserted between the separated flaps. When the pressure is relieved the flaps are thus tightly packed on the ring.

The ring may also be split with the ends interlocked by notches or the like. In this case the flaps need not have slits but must have holes near the edges which are to form the radially inner periphery of the annulus. In this case the ring is separated at the split and the flaps in bundles with the holes aligned are slipped over the ends of the ring. When the flaps are tightly packed the ring is permitted to spring back so that its ends interlock.

When the annulus is assembled flanges are placed on each side of hub to keep the annulus aligned. Adhesive is then applied. The adhesive should penetrate beyond the ring so that the ring serves as reinforcement for the adhesive analogously to the metal in reinforced concrete. The ring should preferably be positioned in the region where the hub is tensioned when stress is applied to it.

The charring of the flaps during use is prevented by cooling the wheel. For this purpose the wheel is provided with cooling slots extending radially inwardly. Each flap has at least one slot extending inwardly from the radially inner end. When the flaps are formed into an annulus the slots are aligned to form a slot having the configuration of a disc. The slots extend beyond the parts of the surfaces where the adhesive penetrates.

When the annulus is being prepared for rotation to inject the adhesive the slot is masked by tape which may be removed before or after curing. The slot provides a passageway for cooling air.

To suppress the fraying, the flaps are cut out from the matrix cloth on a bias.

The novel features considered characteristic of this invention are disclosed generally above. The invention itself both has to its organization and as to its method of operation, together with additional objects and advantages thereof, will be understood from the following description of specific embodiments taken in connection with the accompanying drawings, in which:

FIGURE 1 is a view in side elevation of a flap used in the practice of this invention;

FIG. 1*a* is a view in side elevation showing how the flaps shown in FIG. 1 are mounted in a solid ring to form an annulus;

FIG. 2 is a view in side elevation showing how the flaps shown in FIG. 1 (or like flaps without slits) are mounted on a split ring to form an annulus;

FIG. 3 is a fragmental view showing how the ends of the ring interlock;

FIG. 4 is a view in longitudinal section showing apparatus of one type for practicing this invention;

FIG. 5 is a view in longitudinal section showing apparatus of another type for practicing this invention;

FIG. 6 is a view in longitudinal section showing apparatus of a third type for practicing this invention;

FIG. 7 is a view in perspective showing a polishing wheel in accordance with this invention;

FIG. 8 is a view in longitudinal section showing the manner in which a polishing wheel in accordance with this invention is used;

FIG. 9 is a view in perspective showing a polishing wheel in accordance with a modification of this invention; and

FIG. 10 is a view in section showing a polishing wheel in accordance with another aspect of this invention.

The flap **11** in accordance with this invention is of generally rectangular form with a stem **13** extending from one side of the rectangle. The stem has notches **15** and **17** and **19** and **21** which are symmetrically disposed with reference to the longitudinal axis of the stem. The stem **13** also has a slit **23** (FIG. 6) which terminates in a hole **25** and a pair of slots **27**. The slots **27** extend an appreciably greater distance from the end of the stem **13** than the hole **25**. The flap **11** is preferably coated with an abrasive on one side and is smooth on the opposite side.

In the practice of this invention a large number of flaps **11** are formed into an annulus in which the flaps are tightly packed. The annulus is produced by stringing the flaps **11** on a solid ring **30**. Bundles of the flaps **11** are assembled with the slits **23** and the holes **25** aligned and are mounted on the ring **30** by slipping the ring **30** through the slits **23** until the ring **30** engages the holes **25**. When the ring **30** is substantially filled, adjacent flaps **32** and **34** at one point are pressed back and clamped, and additional flaps **11** are slipped onto the ring **30**. Flaps **32** and **34** are then released and a tightly packed annulus is formed.

The flaps **11** may also be strung onto a resilient split ring **31**. In this case the slits **23** may be omitted. The ends **33** and **35** of the ring **31** are provided with mating notches **37** and **39** which overlap so that in the closed posiiton the ring **31** is locked by the engagement of the notches **37** and **39**.

In forming the annulus the ring **31** is opened and the flaps **11** are mounted on the ring by threading the holes **25** in the flaps over the split ends of the ring. A plurality or bundle of flaps may be strung onto the ring during each stringing operation. Each bundle should be assembled so that the slits **23** are coextensive and the slits of the bundle should be passed together over the ring **31**.

When a sufficient number of flaps **11** have been strung on the ring **31** to form a tightly packed annulus the ends **33** and **35** are released and permitted to snap into engagement. The annulus **40** which is thus formed has a hub supported on ring **31**, circular grooves formed by the notches **15**, **17**, **19** and **21** and circular slots formed by the slots **27**.

The rings **30** and **31** may be composed of metal. While mild steel or aluminum may be used, spring steel is preferred in certain situations.

The annulus is now provided with a solidified hub. For this purpose the stems **13** are secured together by an adhesive. The adhesive may be formed by combining a resin such as HYSOL 2030 or Bakelite ERL–2774 with a hardener such as diethylene triamine, Bakelite ZZLD–0814 or combinations of the diethylene triamine and Bakelite ZZLD–0814. The adhesive consists of 100 parts by weight of resin and 10 to 40 parts by weight of hardener. The hardener may have any composition between 100% triamine and 0 of "0814" and 0 of triamine and 100% of "0814." HYSOL 2030, Bakelite ERL 2774, and Bakelite ZZLD–0814 are epoxy resins. HYSOL 2030 is sold by Houghton Laboratories Inc. of Olean, N.Y. and is described in Houghton Technical Data #20–1 dated February 1958. ERL 2774 is described in Epoxy Technical Bulletin No. 4 of Union Carbide Corp. and ZZLD–0814 in its New Product Engineering Department Technical Release No. 7.

The adhesive so formed is a liquid and is injected between the surfaces of the stems **13** by centrifugal force. The higher the triamine the lower the viscosity of the adhesive.

For this purpose, a receptacle **41** (FIG. 4) mounted on a turntable **42** to rotate about a vertical axis is provided. The receptacle **41** includes a cylindrical wall **43** and the space within which is closed by upper and lower plates **45** and **47**. The lower part **49** of the wall **43** is solid and the upper part **51** is perforated. The lower plate **47** may be secured to the lower part **49** of the wall **43**, for example, by welding and has a projection **53**. An annular trough is thus formed between the projection **53** and the part **49** in which the liquid adhesive **55** is disposed. The upper plate **45** may be flat. This plate may be removably mounted on the wall **43**. Each of the plates **45** and **47** extends beyond the wall **43** and the extending portions are provided with annular projections **61**, **63**, **65** and **67** adapted to engage the grooves **15**, **17**, **19**, **21** of the annulus **40**.

In the practice of this invention the plate **45** is removed from the wall **43** and the adhesive **55** is poured into the trough between part **45** and projection **53**. The circular slots **27** in the annulus **40** are then closed by strips of adhesive tape **71** extending around the radially inner wall of the annulus **40** at the slots **27**. The annulus **40** is then mounted encircling the wall **43** with its grooves **17** and **21** engaging the projections **65** and **67**. To facilitate removal of the annulus after treatment, polyethylene sheet or silicone parting agent (not shown) may be interposed between the grooves **17** and **21** and the projections **65** and **67**. The top **45** is then mounted on the wall **43** with the projections **61** and **63** engaging the grooves **15** and **19**. Polyethylene sheet or a conventional mold release or parting agent (not shown) may also be interposed in this case between the projections **61** and **63** and the grooves **15** and **19**. The annulus **40** should be held tightly between the plates **45** and **47**.

The assembly **41–40** is then mounted on the turntable **42** and rotated. The rotation causes the adhesive **55** to rise along the wall **43** and be projected through the openings **73**. The adhesive impinges on the radially inner periphery **75** of the annulus **40** and because the rotation of the annulus **40** is injected between the surfaces of the stems **13** of the flaps **11**. Sufficient adhesive flows down the wall **75** to provide for coating of the portions of the surfaces of the stem **13** opposite the part **49** of the wall **43**. The speed of rotation should be so coordinated with the viscosity of the adhesive that the adhesive is injected only to the region just beyond the ring **31** and not beyond the inner ends of the slots **27**. The following

table shows relationships between viscosity, speed and time of injection which have proven satisfactory for the above-described adhesives. The viscosity was set in each case by adjusting the proportions of the hardeners diethylene triamine and Bakelite ZZLD–0814.

Viscosity in Centipoise	Rotational Speed, r.p.m.	Time of Treatments, Minutes
100 to 500	275	3
600 to 1,200	550	2

After being treated as just disclosed the annulus **40** is removed from the receptacle **41** and the adhesive is cured by heating the treated annulus. The tape **71** is then removed. A polishing wheel **81** (FIG. 7) with a solid hub **83** which is not fragile is thus produced. Because of the rotation about a vertical axis the adhesive is uniformly distributed over the hub. The ring **31** serves as reinforcement. The slots **27** which are free of adhesive throughout and communicate with the separable parts of the flaps **11** serve to ventilate the wheel in use.

When the wheel **81** is to be used, it is provided with end plates **91** and **93** having projections **95** which engage the grooves **15, 17, 19, 21**. The plates **91** and **93** have central openings through which a shaft **97** passes. The shaft **97** is threaded and is held in firm engagement with the plates **91** and **93** by nuts **99**. The plates **91** and **93** have perforations **101** in their faces.

In use the shaft **97** is rotated, rotating the wheel **81**. The outer periphery of the wheel **81** is in polishing engagement with the work while the wheel is rotated. The heat developed by the polishing is to a large extent carried away by the cooling air flowing through the holes **101**, the slots **27** and between the unjoined parts of the flaps **11**.

To improve the distribution of the adhesive the annulus **40** is rotated at a different speed than the adhesive. This is accomplished with apparatus as shown in FIG. 5 which includes a cup-shaped receptacle **111** having a solid base **113** and a wall **115** which is solid in the lower part and perforated in the upper part. A vertical shaft **117** extends from the center of the base **113**. The adhesive **119** is disposed in the lower part of the receptacle **111**. The apparatus also includes lower and upper plates **121** and **123** each having annular projections **125** and **127** adapted to engage the grooves **15, 17, 19** and **21** in the annulus **40**. A hollow shaft **131** extends from the lower plate **121** and this plate is also provided with an opening coaxial with the shaft **131** adapted to accommodate the shaft **117**.

When this apparatus is to be used the plate **121** is mounted on a bearing plate **133** with a bearing ring **135** extending from plate **121** engaging bearings **137** in plate **133**. The receptacle **111** with the adhesive **119** in the base is mounted on plate **121** with the shaft **117** extending through plate **121** and shaft **131**. The shaft **117** extends below shaft **131**. The annulus **40** (with slots **27** taped) is then mounted on plate **121** (preferably with polyethylene sheet or a suitable mold release agent interposed between **17, 21** and **125**). The upper plate **123** is then mounted on the annulus **40** and bolted to the lower plate **121** by bolts **141** passing between the receptacle **111** and the annulus **40**. The shafts **117** and **131** may then be provided with driving pulleys **143** and **145** and the annulus assembly **40–121–123** and receptacle **111** rotated at different speeds. The direction of rotation may be the same or opposite.

The speed of the receptacle is so related to the viscosity of the adhesive **119** that the adhesive is projected on the radially inner surface **75** of the annulus. The speed of the annulus is so related to the viscosity of the adhesive that the adhesive is injected between the surfaces of the stems **13** as described above. After this treatment the annulus is cured and a polishing wheel **81** as described above is produced.

The adhesive may also be injected into the annulus **40** under pressure. For this purpose the apparatus shown in FIG. 6 is provided. This apparatus includes a flange stub **161** and cooperative plate **163**. The flange **165** of the stub **161** includes projections **167** adapted to engage the grooves **19** and **21**. The plate **163** has like projections **169**. The annulus **40** is compressed between the flanges **165** and **163** by bolting the plate **163** to the stub **161**. O-rings **171** and **173** are compressed between the grooves **15** and **19** and the projections **167** and **169**. Adhesive is then injected under pressure through openings **175** in the plate **163**. The pressure causes the adhesive to penetrate between the surfaces of the stems **13**. After this treatment the annulus **40** is cured.

A modified wheel **191** in accordance with this invention is shown in FIG. 9. This wheel is made up of flaps **193** which do not have slots **27**. The flaps **193** may be formed into an annulus and treated in the same manner as the flaps **11**. A wheel **191** having a solid hub is thus formed. After the wheel is formed holes **195** are drilled through the hub. This object may be accomplished by separating the unjoined ends of the flaps **193** at selected regions and drilling through the hub at these points. The holes **195** serve for ventilation purposes.

In the wheel shown in FIG. 10 the flaps **11** and spacers **301** alternate. Thes pacers **301** may be made of wood or cardboard. The wheel shown in FIG. 10 may be joined at the radially inner ends in the same way as the other polishing wheels.

While preferred embodiments of this invention have been disclosed herein, many modifications thereof are feasible. This invention then is not to be restricted except insofar as is necessitated by the prior art.

I claim as my invention:

1. The method of forming a polishing wheel from a plurality of flaps comprising forming said flaps into an annulus, confining a liquid epoxy-resin adhesive within the opening of said annulus in communication with the ends of said flaps bounding said opening, rotating said adhesive at a first predetermined speed so that said adhesive is caused by centrifugal force to penetrate into said ends of said flaps, rotating said annulus at a second speed different from said first speed so that said adhesive which has penetrated into said ends is caused by centrifugal force to penetrate between the surfaces contiguous to said ends, and thereafter heating said adhesive to cure said adhesive so that said adhesive hardens forming said annulus into a wheel with a substantially solid hub, the viscosity of said adhesive being so related to said first and second speeds that said adhesive penetrates between said contiguous surfaces only for a predetermined distance along said flaps, said distance being such that said flaps extend freely from said hub over a substantial portion of their length.

2. The method of forming a polishing wheel from a plurality of flaps comprising forming said flaps into an annulus, providing a chamber bounded by the ends of said flaps defining the inner opening in said annulus, injecting an epoxy-resin adhesive under pressure into said chamber to cause said adhesive to penetrate between the portions of said flaps near said ends of said flaps, said pressure being set with respect to the viscosity of said adhesive so that said adhesive penetrates between said portions only a predetermined distance, and thereafter heating said adhesive to cure said adhesive so that said adhesive hardens forming said annulus into a wheel with a substantially solid hub, said distance being such that said flaps extend freely from said hub over a substantial portion of their length.

3. The method of forming a polishing wheel from a plurality of flaps comprising forming said flaps into an annulus, providing an annular chamber bounded by the ends of said flaps defining the inner opening in said an-

nulus on one side and by a solid wall on the opposite side, injecting an epoxy-resin adhesive under pressure into said chamber to cause said adhesive to penetrate between the portions of said flaps near said ends of said flaps, said pressure being set with respect to the viscosity of said adhesive so that said adhesive penetrates between said portions only a predetermined distance, and thereafter heating said adhesive to cure said adhesive so that said adhesive hardens forming said annulus into a wheel with a substantially solid hub, said distance being such that said flaps extend freely from said hub over a substantial portion of their length.

4. The method of forming a polishing wheel from a plurality of flaps comprising forming said flaps into an annulus, confining a liquid epoxy-resin adhesive in the opening of said annulus in a substantially horizontal pool in communication with the ends of said flaps bounding said opening, rotating at least said adhesive at a predetermined speed about a vertical axis so that said adhesive is caused by centrifugal force to penetrate by movement generally horizontally generally symmetrically about said axis between the inner surface of said flaps, and thereafter heating said adhesive to cure said adhesive so that said adhesive hardens forming said annulus into a wheel with a substantially solid hub, the viscosity of said adhesive being so related to said speed that said adhesive penetrates between said inner surfaces only for a predetermined distance along said flaps, said distance being such that said flaps extend freely from said hub over a substantial portion of their length.

5. The method of forming a polishing wheel from a plurality of flaps and a solid ring, each flap having a slit on one end thereof terminating in a hole within said flap, said hole being dimensioned to accommodate said ring, the said method comprising, forming a tightly packed annulus of said flaps on said ring by slipping said ring through the slits in said flaps to a position in which said ring extends through said holes in said flaps, said annulus having a central opening, confining a liquid adhesive in said opening in communication with said one end of said flaps, rotating said annulus at a predetermined speed so that said adhesive is caused by centrifugal force to penetrate between the surfaces of the flaps at said one end, and thereafter heating said adhesive to cure said adhesive so that said adhesive hardens forming said annulus into a wheel with a substantially solid hub.

6. The method of forming a polishing wheel from a plurality of flaps and a solid ring, each flap having a slit on one end thereof terminating in a hole within said flap, said hole being dimensioned to accommodate said ring, the said method comprising, forming a tightly packed annulus of said flaps on said ring by slipping said ring through the slits in said flaps to a position in which said ring extends through said holes in said flaps and forming a substantially solid central hub on said annulus by injecting an adhesive between the portion of said flaps in the region of said ring to cause said portion of said flaps to solidify.

7. The method of forming a polishing wheel comprising an annulus of flaps extending from a substantially solid core at the center formed by the adhesion of the ends of said flaps at said core, the said method comprising the steps of forming the annulus by slipping flaps edgewise onto a solid ring through slits near said ends of said flaps which form the core, the slit of each said flap terminating in a hole that engages the ring, sufficient flaps being slipped on said ring to form a preliminary annulus extending substantially around the whole ring; thereafter separating the adjacent flaps at one point of the preliminary annulus and clamping said last-named flaps apart at said point and slipping additional flaps edgewise over the ring through slits near their ends which do terminate in holes that also engage said ring, a sufficient number of additional flaps being slipped over the ring to produce a tightly packed annulus of flaps, applying an adhesive to the end of said flaps which form the core and thereafter curing the adhesive to form a solid core.

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