

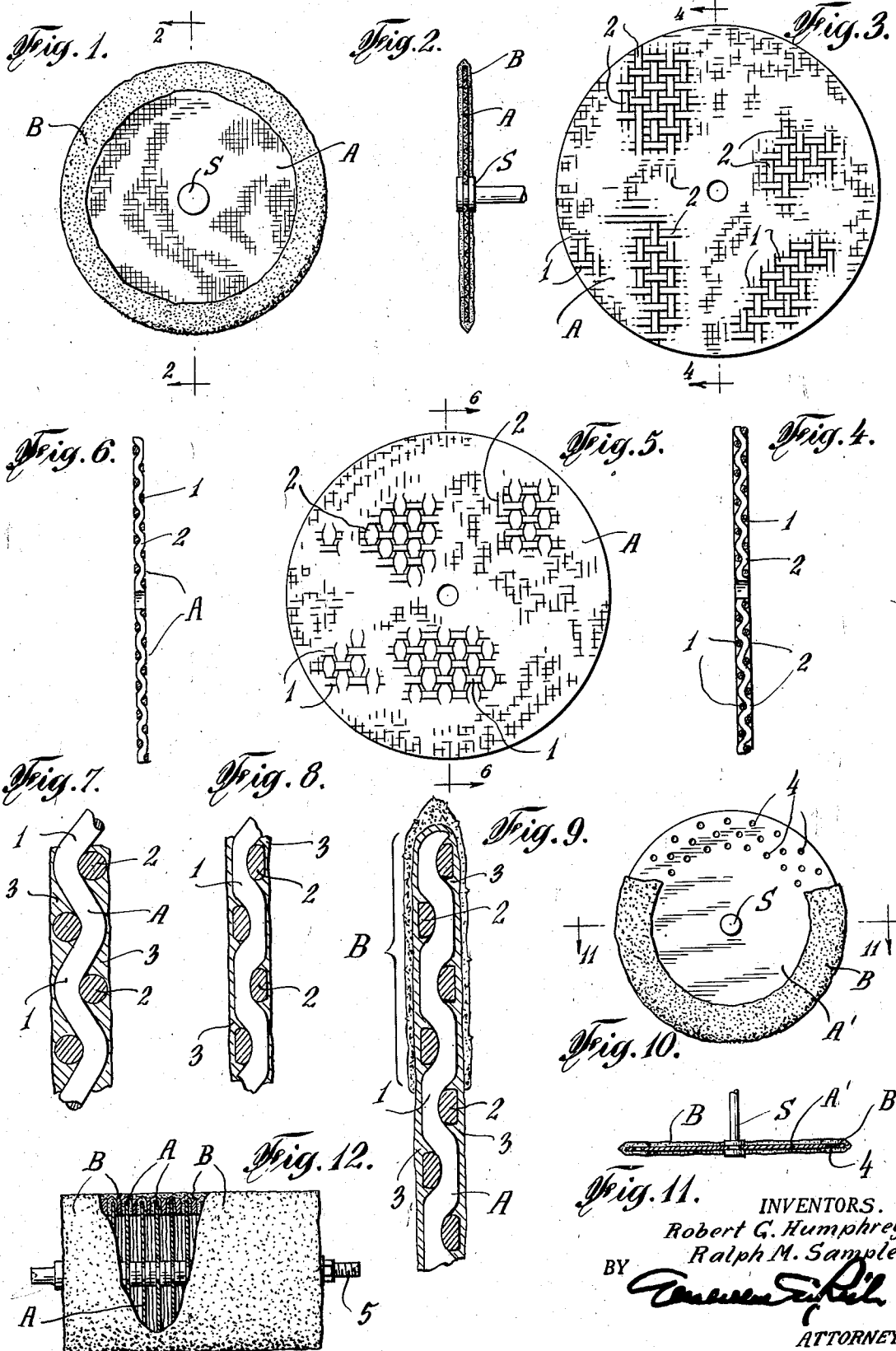
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ABRASIVE DISK

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ABRASIVE DISK

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This invention relates to abrasive compositions of matter and more particularly to cutting and grinding wheels having the cutting or grinding surface thereof comprised of an abrasive composition of matter.

One of the objects of the present invention is to provide an improved abrasive manufacture and more particularly an improved cutting or grinding wheel.

Another object is to provide a cutting or grinding wheel adapted for use at relatively high rotative or cutting speeds.

Still another object is to provide a cutting wheel of relatively thin section adapted for use at relatively high cutting speeds.

Other objects will be apparent as the invention is more fully hereinafter disclosed.

In accordance with these objects we have discovered that by disposing an abrasive composition consisting of abrasive particles dispersed throughout a bonding matrix upon the face of a plane surfaced base member provided with a plurality of spaced openings in the plane surfaced area thereof having a size, shape and configuration adapting the same to function as keyways for the interlocking securement of the said abrasive composition to the said plane surface of the base member, an improved abrasive manufacture results.

The invention is adapted to extensive modification depending upon the specific abrasive manufacture to be made; upon the specific materials comprising the base member and the abrasive composition employed in combination therewith and upon several other factors.

By a proper choice and selection of the form and substance comprising the said base member and abrasive composition to be utilized therewith, a relatively large number of abrasive manufactures may be constructed. As a specific embodiment of the invention, the invention will be described as it has been adapted to the manufacture of cutting wheels, particularly cutting wheels of relatively small thickness.

In the adaptation of the invention to the manufacture of cutting wheels, we have found it desirable to provide a disk-shaped base member having a thickness materially less than the desired cutting thickness of the cutting wheel and which is provided at least in the area next adjacent the peripheral edge thereof with a plurality of spaced openings over which area is dispersed the said abrasive composition in a relatively thin layer, as compared to the thickness of the said base member, with the said abrasive

composition extending into and through the said openings and interlockingly engaging the said base member thereby.

More particularly we have found it most desirable to employ a disk-shaped base member comprised of screen or grid material, and still more particularly, for use with abrasive compositions consisting of abrasive particles of matter dispersed throughout a metallic matrix, a base member consisting of a disk-shaped member consisting of screen material comprised of metallic wires.

We have discovered that by disposing the abrasive composition of matter, consisting of a mixture of abrasive materials dispersed throughout a metallic matrix, in a relatively thin layer upon the opposite faces of a disk-shaped base member, consisting of a metallic screen, over an extended distance inwardly from the outer edge thereof with the said disk-shaped member mounted at its axial center upon a suitable spindle, cutting wheels of less than 80 mil thickness down to as low as 4 to 6 mil thickness may easily be produced, which are capable of operation at relatively high rotative speeds over relatively prolonged time periods of service use, particularly where in addition to the interlocking engagement of the abrasive composition through the mesh openings of the disk member, there is also provided means to alloy-bond the metallic constituent of the abrasive composition of matter to the surface of the said base member and also to mechanically or alloy-bond secure together the crossing wires of the said base member into an integral structure.

Before further disclosure of the present invention reference should be made to the accompanying drawing, wherein—

Fig. 1 is a top view of a cutting wheel constructed in accordance with the present invention;

Fig. 2 is a sectional view along plane 2—2 of Fig. 1;

Fig. 3 is a top view of the disk-shaped member forming the base of the cutting wheel shown in Fig. 1;

Fig. 4 is a sectional view of the same taken along plane 4—4 of Fig. 3;

Fig. 5 is a top view illustrating a contemplated modification of the member of Fig. 3;

Fig. 6 is a sectional view of the same taken along plane 6—6 of Fig. 5;

Fig. 7 is an enlarged section illustrating a second contemplated modification of the present invention;

Fig. 8 is a second enlarged view illustrating the modification of Fig. 7 as further modified by the improvement feature of Figs. 5 and 6;

Fig. 9 is an enlarged sectional view illustrating a preferred structure in the practice of the present invention;

Fig. 10 is a top view partly in section illustrating another contemplated modification in the disk-shaped member of the present invention;

Fig. 11 is a sectional view of the same taken along plane II—II of Fig. 10, and

Fig. 12 is a side elevational view partly in section of a grinding wheel constructed in accordance with the present invention.

Referring to the drawing, Figs. 1 and 2, the cutting wheel of the specific embodiment of the present invention consists of a disk-shaped base member A, which in the preferred form consists of woven metal screen material, having a spindle S secured thereto at its axial center and having an abrasive composition A secured onto the opposite flat surfaces thereof for an extended distance inwardly from its peripheral edge.

Disk-shaped member A may consist of any desired metal or metallic alloy having the requisite strength and ductility to retain its shape upon high speed rotation about its axial center. In the manufacture of cutting wheels it has heretofore been the objective to reduce the thickness of the wheel to the minimum consistent with safety at the revolutionary speeds employed. It is exceedingly difficult by any of the means heretofore proposed to construct a cutting wheel capable of making cuts as small as 10 to 15 mils in width which is operative at any high speed with any extended service life. By the practice of the present invention not only may wheels of 10 to 15 mils thickness be easily produced but wheels of 4 to 8 mils thickness can be produced without exceeding difficulty which are not only operative at relatively high cutting speeds over an extended service life, but are also operative either wet or dry over an extended service life heretofore never even approximated.

As one specific example of the specific embodiment of the present invention, but not as a limitation thereof, we will describe the invention as it has been applied in the manufacture of cutting wheels of about 12 mils thickness.

In the manufacture of wheels of this type, we prefer to employ a disk-shaped member A comprised of woven wire screen. Many different metals and metal alloys are utilizable in the forming of the woven wire screen and the composition, per se, of the said disk-shaped member A forms no part of the present invention.

Preferably, and for use with the specific abrasive compositions hereinafter disclosed, we prefer to employ a woven metal screen consisting of a metallic composition which is capable of forming a surface alloy with a noble or platinum group metal and which is resistant to physical deterioration on repeated heat-treatment to temperatures approximating 700° C. Such a metallic composition, for example, comprises substantially pure nickel, or, alternatively, a nickel-copper alloy known in the art as Monel metal. Other metallic compositions, however, are equally as suitable.

The selection of a disk-shaped base member comprised of a metallic screen consisting of nickel or a nickel base alloy is dictated as much by the method of securing the abrasive composition B to the said disk-shaped member A, as will hereinafter be disclosed, as by any other consideration and other methods of securing the said abra-

sive composition B to the said disk-shaped member A as well as the use of other abrasive compositions than that hereinafter described, will lead obviously to a preference for other metallic compositions for member A.

Heretofore in the art many different abrasive compositions have been proposed for use in grinding and cutting wheels. One of the most successful of such abrasive compositions consists of sized particles of an abrasive dispersed throughout a metallic matrix.

Many different abrasive materials and of metallic matrices for use therewith have heretofore been proposed and, per se, form no part of the present invention, except in combination with the base member of the present invention.

There are also many different methods of obtaining an abrasive composition of matter, consisting of particles of an abrasive dispersed throughout a metallic matrix, one of the most successful being to disperse the sized particles of the abrasive throughout finely divided metal powder, compacting and sintering the compacted mixture to a temperature and for a time interval adapted to produce a sintered product of the required density and strength. In this method, obviously, the modus operandi varies widely depending upon the particular abrasive material employed and the particular metal powder or mixture of metal powders employed therewith.

In the manufacture of cutting wheels, it is, of course, preferable to employ an abrasive which is hard enough to cut anything. Diamond fragments are the hardest abrasive known, and alone or in combination with other abrasives such as metal carbides, borides, nitrides and silicides, are to be preferred in the practice of the present invention. The utilization of diamond fragments in the forming of an abrasive composition consisting of diamond fragments dispersed throughout a metallic matrix requires the exercise of certain precautionary measures and the utilization of certain types of metal powders which are not necessarily required where any of the other abrasives are employed.

The selection of diamond fragments as the abrasive material for use in the present invention, normally imposes a temperature limitation of between 700 and 800° C. as the maximum temperature of heat-treating to which the wheel may be subjected, as above this temperature some types and kinds of diamonds lose a part of their hardness. The exact reason for this is unknown. It may be due to some type of crystallographic change or alteration, or it may be due only to oxidation or solution of the sharp cutting edges of the diamonds in the metal powders with which it is in contact. Where the diamond fragments are protected against reaction with metals and oxygen, materially higher temperatures may usually be employed without detriment to the cutting hardness of the fragments.

With this consideration in mind, we have devised the following method of constructing the cutting wheel product of the present invention where sized diamond fragments are employed as the abrasive constituent:

The disk-shaped member A which consists, preferably, of a metal wire screen comprised of nickel of a nickel-base alloy having a thickness materially smaller than the maximum cutting thickness desired which, in the case of a wheel of 10 to 15 mil cutting thickness approximates 8 to 12 mil thickness, is surfaced in any convenient manner as by electrolytic deposition, spray-

ing, dipping, etc., with one of the noble metals gold or silver. We prefer, for economic reasons, to employ silver for this purpose. The thickness of the surface coating of silver applied to member A may vary widely without essential departure from the present invention. The main object of this coating is to provide on heat-treatment at temperatures approximating 700-800° C. a firmly adherent and surface alloyed coating of silver on the member A which, in addition to adhering to the wire surface, functions also to weld secure the woven wire lengths together at each crossing point, thereby to convert the woven wire body into a substantially integral structure. This silver coating is preferably accomplished by dipping the member A in a relatively heavy or viscous suspension of silver metal powder suspended in a solution of a thermally decomposable adhesive such as amyl acetate.

Following surfacing of member A with silver and weld securing the cross-wires together at the plurality of crossing points thereof, a second application of the silver metal powder suspended in the said thermally decomposable adhesive is applied upon both plane surfaces thereof for the desired distance inwardly from the edge thereof and the sized diamond fragments are spread thickly upon the freshly coated area, as many as will be retained thereon. The coating is allowed to dry in air or at elevated temperatures substantially below the thermal decomposition temperature of the adhesive and successive coatings of silver metal powder and diamond fragments are similarly applied until the thickness of the plurality of coatings is considerably greater than the desired cutting thickness of the wheel. In the case of a cutting wheel wherein a cutting thickness of about 12 mil thickness is desired, the thickness of the plurality of coatings obtained as above described, using diamond fragments passing 100 but not passing 120 mesh, should approximate 15 mils.

We then subject the plurality of coatings to compaction under a pressure at least adapted to consolidate the said coatings upon the member A and to force the same into the mesh openings thereof, reducing the thickness of the coatings to approximately that desired in the cutting wheel, but slightly greater. Following such consolidation the member A with the plurality of coatings of silver metal powder and diamond fragments thereon, is subjected to extended heat-treatment to a temperature approximating 700-800° C. for a time interval adapted to effect a sintering together of the silver metal powder of the mixture into a coherent metal body which is weld secured to the silver surface coating of member A. Where, as the result of shrinkage, the thickness of the abrasive composition is less than the thickness desired, one or more additional coatings or alternate layers of silver metal powder and sized diamond fragments may be applied thereto and the assembly again heat-treated as described. Alternatively, instead of compacting before heat-treating we may compact following heat-treatment without substantial difference in the resultant composite product. Also, alternatively, compaction before and after heat-treating may be practiced, if desirable, to obtain a dense structure in the abrasive composition and an integral securing of the same to the surface of the base member.

In general, for an extended service life, we have found it necessary only to provide a thickness of the abrasive composition B (of sized diamond

fragments dispersed throughout silver) which is only a few mils thicker than the thickness of member A. This relation, however, may vary widely without essential departure from the present invention, as one skilled in the art may perceive, depending upon the diameter of the wheel and the wheel thickness, with any given metallic composition of which the member A is comprised. As cutting wheels of the relatively small cutting thickness of the present specific example seldom need to be over 1 to 3 inches in diameter, a wide variety of metal screen thickness may be employed with a wheel of any given cutting thickness particularly in the case of cutting wheels having a cutting thickness above about 20 mils. However, for convenience in manufacturing, we prefer to employ a wire mesh thickness that is from 2 to 4 mils smaller than the cutting thickness desired except in the thicker cutting wheels, thereby to insure adequate strength and resistance to disintegration under the influence of centrifugal forces in the wheel, per se, and in the abrasive composition thus secured onto the wheel periphery.

In general, also, as the cutting wheel thickness decreases, we prefer to reduce the wheel diameter in a more or less regular manner, limiting the wheel diameter at 4 to 6 mils cutting thickness to from ¼ to 1½ inches and the wheel diameter at 10 to 15 mils cutting thickness to from 1½ to 5 inches. Above 20 mils cutting thickness the permissible wheel diameter depends more upon the known physical properties of materials than upon any particular relationship between the cutting wheel thickness and diameter.

One of the factors of the present invention, which is subject to wide variation, is the factor of the size of the mesh openings in the disk-shaped screen member A. In general, the mesh opening of the screen depends in part upon the particular size of diamond fragments employed and in part upon the wheel diameter and thickness.

In general, it seems preferable, with any given diamond fragment size to provide a mesh size that is at least sufficient to permit a plurality of the diamond fragments to be compressively disposed in interlocking relation with the silver matrix therein. Heretofore in the art, it has been found, as a general rule, that diamond fragments having a particle size passing 100 mesh but not passing 120 mesh are most suitable for use in cutting and grinding compositions of matter. In the above specific example, this size of diamond fragment is preferred, although good results have been obtained using diamond fragments as small as those approximating 400 mesh in cutting wheels of minimum thickness and as large as about 40 mesh in cutting wheels of maximum thickness.

With diamond fragments approximating 100 to 120 mesh, we have found that wire mesh screens having mesh openings approximately 75 to 150 mesh size are most suitable for use where the cutting thickness of the wheel ranges from 4 mils up to about 20 mils. As the cutting thickness of the wheel exceeds about 20 mils, and the wheel diameter increases, a mesh opening approximating 40 to 100 mesh appears adequate up to cutting thickness approximating 80 mils, although in cutting wheels of the larger cutting thickness larger diamond fragments preferably are employed. Cutting wheels having cutting thicknesses greater than 80 mils are usually undesirable, for the reason that too much material is

destroyed during cutting, but where the material loss is immaterial and the time factor important, cutting wheels of a thickness greater than 80 mils are utilizable and producible in accordance with the present invention.

We have found, however, that added strength and rigidity may be imparted to disk-shaped member A when it is comprised, as in the specific example described, of woven metal wire, by subjecting the woven metal wire disk member A prior to surface coating with the said noble metal to a flattening operation, as by passing the same through a rolling mill one or more times, which operation should be at least sufficient to materially reduce the thickness of the said screen and may extend to the extent sufficient to produce a grid structure consisting of flattened metal wires lying substantially in the same plane with the crossing wires mechanically secured together into a substantially integral structure. This modification of the present invention is illustrated in Figs. 5 and 6.

Referring first to Figs. 3 and 4, the crossing warp and woof wires 1 and 2, for example, are indicated as they normally appear in a woven wire structure. In Figs. 5 and 6, following flattening, the convolutions of woof wires 2 have been substantially eliminated and the rounded structure of the warp and woof wires 1 and 2 destroyed and replaced by a flattened structure. This is more specifically illustrated in Figs. 7 and 8, wherein also is incorporated the feature of providing the surfacing and warp and woof weld securing metal 3 thereon to convert the woven metal structure into an integral body. It is believed apparent that a structure alternative to that illustrated in Figs. 5 and 6 and substantially equivalent thereto, particularly following alloy-bonding of the crossing wires, is a grid structure consisting of a perforated sheet of metal, illustration of which in view of Figs. 5, 6 and 8, appears unnecessary.

In the modification of Figs. 5 and 6, the mechanical strengthening of the mechanical interlocking of warp and woof wires 1 and 2 obtained by reason of the flattening operation in addition to the weld securing by surfacing metal 3, enables us to more easily obtain the smaller cutting thicknesses in cutting wheels constructed in accordance with the present invention. We may employ, for example, wire mesh screens of the same or of several mils greater thickness than the desired cutting thickness, and by such flattening operation reduce the thickness of the screen to from 1 to 2 mils less than the desired cutting thickness, increasing the strength of the member A sufficiently, thereby to enable us to increase the wheel diameter materially. This modification of the present invention is particularly applicable in a production of cutting wheels having a cutting thickness below about 10 mils.

Referring to Figs. 10 and 11, we have illustrated an alternative structure of utility in the construction of cutting wheels having a cutting thickness in excess of about 20 mils. In such wheels, it is sometimes undesirable to employ wire mesh screens, not only because of the increase in weight involved, which is desirably maintained low in the member A, but, also, the weight and thickness of abrasive material A requires the provision of a stronger sectioned member A than is normally required with thinner sectioned wheels. In this modification, member A consists of a metal disk A', provided in the area adjacent the periphery thereof, over which the said

abrasive composition B is to be located with a plurality of spaced openings 4, each of a size, shape and configuration adapting the same to function as keyways for the weld securing of the abrasive composition B therethrough in a manner substantially equivalent to that obtained by means of the mesh openings of member A of the specific example hereinabove described. The total number of openings 4 in member A' may vary widely as may the size, shape and configuration thereof, without essential departure from the present invention, as one skilled in the art may perceive.

One of the major advantages of the present invention, particularly where member A comprises a metal screen, resides in the peculiar property of the metal screen section which is not covered by abrasive composition B, to pick up and retain liquid coolants desirably employed to facilitate the cutting action of the abrasive composition B during service use. This property, which is characteristic of screen materials generally, results in the progressive feeding of the liquid coolant as a result of the centrifugal forces developed during revolution, towards the peripheral edge where it is the most effective.

Another advantage of the present invention over cutting wheels heretofore developed, lies in the extreme flexibility of the cutting wheel imparted by reason of the wire mesh structure of member A. In thin sectioned cutting wheels this is an exceedingly important advantage as it insures the obtainance of a relatively long service life. In the larger sectioned cutting wheels (over about 20 mil thickness) strength and rigidity are more important factors than flexibility but a certain amount of flexibility is desired in member A nevertheless.

A further advantage of the present invention over cutting wheels heretofore devised, lies in the feature of extending the member A to substantially the maximum diameter of the cutting wheel providing for abrasive composition B thereon, providing thereby the equivalent for a centrally located interlacing reinforcement of strong ductile metal fibers for the mixture of abrasive and metal matrix comprising the same. This combination imparts unusual strength to the normally friable sintered abrasive and metal powder mixture which, when coupled with a weld union between the metal component of the mixture and the interlaced metal wires, results in a structure that tenaciously resists not only disintegration as a result of centrifugal forces but also disintegration as a result of the torsional stresses incident to cutting or abrasive contact of the surface of the material with hard surfaces. This is an important feature from both a safety and health viewpoint, as one skilled in the art will recognize.

As a further improvement of the present invention, we have found it sometimes advisable to surface the cutting wheel constructed as hereinabove described with a finishing surface of a bright tarnish resisting metal such as nickel, chromium, cadmium, zinc or a noble or platinum group metal. We have found it generally preferable to employ nickel as a finishing surface metal, particularly in the combination of elements comprising the cutting wheel of the above specific example, for the primary reason that upon subsequent heat-treatment at temperatures approximating 775° C. the nickel surface coating may be alloy-bonded to the silver metal of the combination, forming therewith a strongly adherent

surface resistant to abrasion and resistant to cracking and peeling upon flexing of the cutting wheel during service use.

Referring to Fig. 12, a grinding wheel consisting of a plurality of separate cutting wheels each constructed as hereinabove described and weld secured together upon a shaft 5 is illustrated. In this type of grinding wheel, by means of the plurality of separate base members A, materially higher resistance to the centrifugal forces generated upon rotation is obtained and relatively high grinding wheel speeds thereby may be employed. The saving in grinding composition material by this structure, alone, is sufficient to warrant adoption by the art.

It is believed apparent from the above disclosure that the present invention may be widely varied without essential departure therefrom and that a wide variety of materials are utilizable in the present invention in substitution for the specific materials hereinabove disclosed. It is also believed apparent that alternative methods are available in the art than that hereinabove described to dispose the abrasive composition upon the disk-shape base member of the present invention. In view thereof, all such modifications and adaptations of the present invention are contemplated as may fall within the scope of the following claims.

What we claim is:

1. In a cutting wheel comprising a metallic disk base member having an annular mass of an abrasive composition secured to the periphery thereof, the improvement which comprises a metallic disk base member consisting of woven warp and weft wires, the said wires being secured together at each crossing point to form an integral grid-like metal structure substantially free of radial flexibility.

2. In a cutting wheel comprising a metallic base member having an annular mass of an abrasive composition secured to the periphery thereof, the improvement which comprises in combination a base member consisting of woven parallel spaced warp and weft wires, the said wires being secured together at each crossing point to form an integral grid-like structure substantially free of radial flexibility and an annular mass of an abrasive composition consisting of a metal bonded abrasive composition enclosing the periphery of said base member with the base member centrally embedded therein, said mass having a thickness and outside diameter approximating but larger than the thickness and diameter of said base member.

3. The combination of claim 2, wherein said metal bonded abrasive composition is alloy bonded to the surface of said base member.

4. The combination of claim 2, wherein the crossing wires at each crossing point are flattened and embedded into each other and are secured in said embedded position by an overlying metal alloy—bonded to the surface thereof.

5. In a cutting wheel comprising a metallic disk base member having an annular mass of an abrasive composition secured to the periphery thereof, the combination of a metallic grid base member substantially free of radial flexibility, said base member consisting of parallel spaced flat

faced warp and weft wires having the weave convolutions flattened to a surface lying in substantially the same plane as the flattened sides of the warp and weft wires, the said wires being secured together at each crossing point to provide an integral metal body, and an annular mass of a metal bonded abrasive enclosing the periphery of said base member with the base member embedded centrally therein, the thickness and outside diameter of said annular body approximating but larger than the thickness and diameter of the said base member.

6. The combination of claim 5, said metal bonded abrasive composition being alloy bonded to the surface of said base member.

7. In a cutting wheel having a metallic disk member arranged for rotation about an axis passing through its center normal to the opposite plane surfaces of the said disk member and having an annular mass of an abrasive composition of matter secured to the periphery of said disk member for axial rotation therewith, the improvement which comprises a disk member comprised of woven metal wires, the said wires at each crossing point being embedded into each other to mechanically interlock the same together and being secured against separation in any direction by means of a surfacing metal alloy—bonding the interlocked wires together to form a laterally flexible metal body of increased strength and resistance to radial deformation.

8. The improvement of claim 7, wherein said disk member comprises a woven metal wire structure characterized by having the weave convolutions and the individual wires thereof flattened on opposite sides to provide opposite parallel plane faces to said disk member with the flattened wires at each crossing point embedded in each other to provide a mechanical interlocking therebetween and wherein the said embedded wires are secured in embedded position by means of a surfacing metal alloy—bonding the crossing wires together, thereby to provide a substantially integral grid-like metal body flexible laterally but resistant to radial deformation.

9. The improvement of claim 7, wherein said annular mass of an abrasive composition comprises a metal bonded abrasive composition having a thickness and outside diameter slightly greater than the thickness and diameter of said disk member, with the disk member substantially centrally located therein.

10. The improvement of claim 7, wherein the said annular mass of an abrasive composition comprises a metal bonded abrasive composition having a thickness and outside diameter slightly greater than the thickness and diameter of said disk member and having opposite plane faces lying in planes substantially parallel to the plane faces of said disk member with the disk member substantially centrally located therein, and wherein the surface of said disk member at least in the area covered by said metal bonded abrasive is provided with a metal coating alloy bonded thereto and to the metal constituent of said metal bonded abrasive.

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