Jan. 20, 1942. L. BUCHMANN 2,270,258

ABRASIVE TOOL AND METHOD OF MAKING SAME

Filed Sept. 21, 1939

FIG. 1.

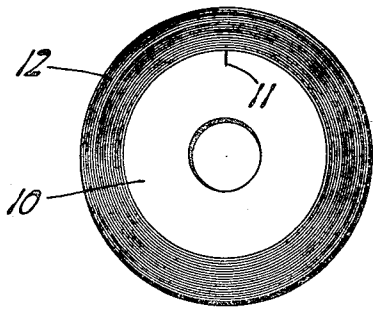


FIG. 2.

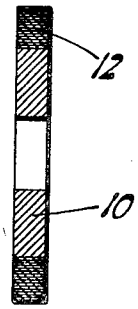


FIG. 3.

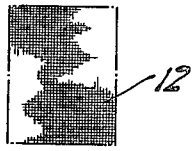


FIG. 4.

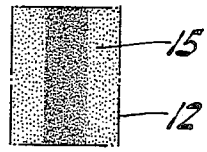


FIG. 5.

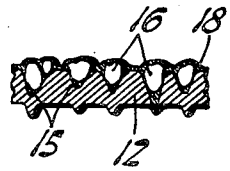


FIG. 6.

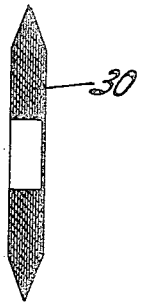


FIG. 8.

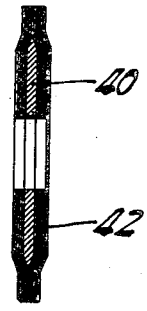
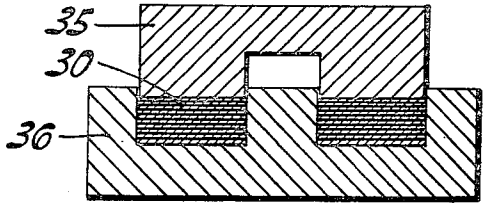


FIG. 7.



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ABRASIVE TOOL AND METHOD OF MAKING SAME

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Application September 21, 1939, Serial No. 295,941

11 Claims. (Cl. 51—309)

This invention relates to abrasive tools and to methods of making the same.

In connection with the manufacture of abrasive tools employing individual abrasive granules it has heretofore been conventional practice to provide the abrasive ingredient in grit form and of sizes depending upon the nature of the work to be performed by the tool; and to bond the grit into the desired form of the tool by means of a bonding medium of refractory or metallic substance. For example, in the case of abrasive wheels employing diamond dust or grains it has been found to be desirable to employ a metallic bonding medium which is as strong and durable as possible in order to prevent loosening and loss of the diamond grains from the wheel prior to their full use as abrasive media. For this purpose various kinds of powdered metals and powdered metallic alloys have been employed, the abrasive grains being first mixed throughout the powdered metal and the mixture then being sintered or fused under suitable conditions of temperature and pressure to form a consolidated mass in the shape of the wheel desired. Such methods, however, involve either homogenous or heterogenous mixing of the abrasive kernels throughout the bonding mass, and it is practically impossible to provide a specially planned form of abrasive ingredient distribution throughout the body of the wheel that is other than either uniform or heterogenous.

Thus, it is impossible under such prior methods to provide accurately planned sectional distribution of abrasive ingredients in varying concentrations throughout the tool body, and, for example, in the case of wheels having working faces of special shapes adapted to grind other than flat surfaces the relatively inactive portions of the wheels contain the same concentrations of abrasive grit as do the active portions thereof. Hence, whenever the wheels are redressed to proper cutting face form substantial losses of unused abrasive grit results, and whenever the abrasive grit is of expensive nature, as in the case of diamond grit, such losses are particularly undesirable. Also, it will be understood that since the abrasive grits are distributed in equally concentrated form throughout the active and inactive sections of the wheel, the work of trimming away the unused portions in connection with redressing the wheel will be laborious and expensive. Another disadvantage of the prior art methods of making sintered abrasive wheels resides in the fact that the fused bonding medium is required to provide the necessary resistance to structural strains under operating conditions, and if the fusion process is not adequate to provide the necessary structural strength the use of such wheel is uneconomical and fraught with danger.

One object of the invention is to provide an abrasive tool comprising individual abrasive grains and a bonding medium for uniting the whole into an integral structure of improved strength; the abrasive grains being distributed throughout the structure in an improved manner and in accord with a predetermined plan of arrangement.

Another object of the invention is to provide an improved abrasive wheel of increased structural strength.

Another object of the present invention is to provide an improved method of introducing the abrasive granules into the bonding medium during manufacture of abrasive tools.

Another object of the invention is to provide an improved abrasive wheel in which the abrasive ingredients thereof are distributed throughout the body of the wheel in an improved manner and whereby the degree of concentration of abrasive granules is increased throughout those portions of the wheel that are called upon to provide the majority of the work-cutting action during service of the tool.

Another object of the invention is to provide an abrasive wheel wherein the abrasive granular ingredients thereof are distributed throughout the body of the wheel in such manner as to expedite and make more economical the redressing of the cutting face of the wheel subsequent to intermittent use thereof in an improved manner. Other objects and advantages of the invention will appear from the specification herein.

In the drawing:

Fig. 1 is a section through an assembled structure preliminary to manufacture of a wheel of the invention;

Fig. 2 is a transverse section through the structure of Fig. 1;

Fig. 3 is a fragmentary view of one form of structural element of the wheel of the invention;

Fig. 4 is a view similar to Fig. 3 of another form of the same structural element;

Fig. 5 is a fragmentary section of a strip element of the structure of the invention showing abrasive grains applied thereto by means of a temporary bonding medium;

Fig. 6 is a section corresponding to Fig. 2 of another form of the invention;

Fig. 7 is a diagrammatic view in section of a

step of the process of manufacturing the wheel of Fig. 6; and

Fig. 8 is a section similar to Figs. 2 and 6 of another form of wheel of the invention.

In practicing the invention, the abrasive grits to be employed are united with a novel form of bonding medium which is made up by assembling in laminated manner sheets of the bonding material. For example, as illustrated in Fig. 1, a wheel of the invention is shown as comprising a metallic core 10 around about the periphery of which has been wound a metallic strip 12 to provide a plurality of layers, the number of which depends upon the desired depth of the working portion of the wheel. As illustrated in Figs. 3 and 4, the metallic strip 12 may be either of meshed wire fabric form (Fig. 3) or of strip metal form provided with minor perforations or indentations 15 (Fig. 4), or in any other suitable form to provide the features hereinafter described.

The abrasive granules for the wheel are positioned upon the metallic strip 12 prior to the wrapping of the strip about the core 10 by spreading a supply of the loose granules across the strip 12, during which operation the interstices of the wire mesh of Fig. 3 or the indentations of the strip of Fig. 4 will receive individual abrasive grains in embraced relation therein. The spreading and adhesion of the abrasive grains upon the strip 12 may be facilitated by first mixing the grains in a plastic carrier such as some neutral oil or grease or other liquid or semi-liquid substance that will provide a temporary bond between the abrasive grains and the strip to prevent dislodgment of the grains from the strip during the process of wrapping the strip about the core 10. Fig. 5 illustrates such application of abrasive grains 16 to the pockets 15 by means of a plastic carrier 18. Preferably, the grain carrier substance will be of some chemically neutral form of grease or oil or the like that will evaporate or otherwise become dispelled during the subsequent processes of the invention without deleterious effects upon the finished structure. To assist in connection with the starting of the process of winding the strip 12 about the core 10 a slot 11 (Fig. 1) may be formed in the periphery of the core to receive an end portion of the strip and to hold the latter against sliding movement relative to the core during the winding process. Upon completion of the process of winding the strip about the core 10, the wheel is placed in a furnace and/or otherwise subjected to an elevated temperature at about the degree of initial fusion of the metal of the strip 12 for a length of time sufficient to provide thorough welding of adjacent portions of the grit-carrying strip without allowing the bulk of the metal thereof to become so fluid as to allow the impounded abrasive particles to move relative to the mass. In some cases, an application of pressure upon the structure during the heating process will also be beneficial and of assistance in providing a thorough welding. Thus, a rugged welded structure is provided wherein the metallic binding portions thereof are essentially of structurally undisturbed form but welded together into an integral mass, thus avoiding burning or other deleterious action with respect to the metal of the structure. This provides a wheel of greater structural strength as compared to the so called "sintered" wheel of the prior art which are made by fusing powdered metallic mixtures. In the case of such sintered types of wheels the finished product is of crystalline-like structural form and resembles in appearance a crusty mass of granules adhering to one another by reason only of intermittent and spaced points of welded contact, and the mass is usually interspersed with a multitude of minor voids. Thus, the abrasive grains are at best only partially surrounded by and attached to the bonding material. In order to avoid deleterious effects upon the abrasive grain substance it is necessary to limit the sintering heat to as low a temperature as may be possible to obtain adhesion between the grains; and it is difficult in such cases to obtain complete sintering of the mass without overheating portions thereof. Consequently, the finished products of such methods are usually non-uniform as to structural strength and often contain weak zones which are apt to cause unduly rapid wearing and/or disruption of the mass when used under heavy duty or high speed conditions. As distinguished from such prior types of abrasive material structures, the laminal body elements of the invention, upon being fused together into an integral mass, provide a tool that is made up of a plurality of united solid metallic bodies extending throughout the tool structure; and therefore, even though the fusion process of the method of the present invention may not in some instances be carried out to perfection between all of the adjacent surface portions thereof, the tool will nevertheless be reenforced throughout by the unaltered integral solid metallic bodies. Thus, in no case will the tool of the invention be subject to disruption under stress in the manner of sintered wheels, or the like. In the case of production of tools of the present invention in the form of abrasive wheels as illustrated in Figs. 1 and 2 of the specification, it will be seen that the laminated strip structure 12, upon being welded together provides a wheel that is positively reenforced circumferentially against centrifugal and/or other forces which tend to disrupt it during use.

The avoidance of conditions of fluidity in the metal of the structure during the fusion process precludes the possibility of redistribution of the abrasive grains in the mass and/or undesirable segregation thereof as would otherwise occur under conditions of mass metal fluidity; and the planned distribution of abrasive particles throughout the wheel mass is accordingly obtained in the finished product. As illustrated in broken lines in Fig. 2, the wheel may be dressed to the form of a V-shaped groove cutting wheel, or into any other special form by means of any suitable dressing operation. For example, the peripheral face of the wheel, instead of being flat as shown in Fig. 2, may be subsequently dressed to concave or convex form, or into any other special shape as may be required in connection with the cutting of stock in the various industries to which the use of an abrasive wheel may be applied. Also, it is contemplated that the strip 12 may be bent or dished or otherwise deformed in any desired manner before being wrapped around the core 10 so as to provide an interlocking laminated structure in which the sectional elements thereof are other than flat as illustrated in Fig. 2.

It is contemplated that various kinds of abrasive granules may be employed in connection with the method of the invention and that the sizing of the abrasive granules will be regulated as desired and in accordance with the character of the work to be done by the wheel. Also, it is contemplated that the strips 12 may be formed of a variety of suitable materials such as any of the

well known fusible metals and/or metallic alloys and/or nonmetallic materials, according to the type of bonding connection that is desired between the adjacent layers and the abrasive grains. It is also contemplated that the heat of the fusing operation may in some cases be limited in such manner that only partial fusion of the adjacent metallic body elements takes place, and that in such case a section taken through the tool transversely of the planes of the lamina thereof will reveal that the internal structure appears to indefinitely bear resemblance to the prior laminated structural form. On the other hand, the fusion process may be carried out to such extent that all evidence of the original laminated structural form will have disappeared, and in such case a section taken in any direction through the finished product will reveal simply a homogeneous, dense, coalized metallic mass in which are interspersed the abrasive particles in accord with the predetermined plan of their relative arrangement therein.

It is also contemplated that in connection with the initial deposition of the abrasive granules upon the strip 12 any suitable means for accomplishing the desired distribution may be employed, and that in lieu of the oily or greasy carrier referred to hereinabove, any other form of paste or liquid may be employed, or that the abrasive grains may simply be dusted into the interstices of the strip without the use of any carrier substance.

Whenever the stock to be operated upon by the wheel is not initially shaped complementary to the shape of the wheel cutting face, that section of the wheel that is called upon to do the majority of the work will preferably be provided with an increased concentration of abrasive kernels as compared to the other portions of the wheel. To obtain such an arrangement of abrasive kernel concentration, the strip 12 may be provided with an increased number of grain receiving depressions in the region of the desired increased grain concentration, and when the diamond or other abrasive grits are dusted or painted upon the surface of the strip they will embed themselves in the strip according to the predetermined plan of uneven arrangement. For example, as illustrated in Fig. 4, an increased number of depressions 15 are provided in the central portion of the strip 12, and when the abrasive grain substance is applied thereto a larger number of grits per unit of area will become embedded in the central portion of the strip as compared to the side edge portions thereof. Hence, when the strip 12 is wound about the core 10 and fused into place thereon the central section of the wheel will be richer in abrasive grit as compared to the side portions thereof. Consequently, the abrasive grit is employed in accurately controllable manner, and wasteful employment of abrasive kernels in the relatively inactive portions of the wheel is avoided thus effecting substantial economies whenever the abrasive kernels are of the expensive type such as diamond dust or the like. Also, it will be seen that because of the fact that the relatively inactive portions of the wheel are of reduced abrasive character, the process of redressing the wheel after the design of the cutting face has been deformed will be less difficult and will involve less loss of valuable abrasive material.

It will be seen that the desired kind of abrasive distribution throughout the wheel section may be obtained in ways other than hereinabove described in connection with preparation of the strip 12. For example, in lieu of the use of an increased number of depressions 15 at the center of the strip, a strip of uniformly deformed character may be employed and the abrasive grits may be applied thereto in such manner as to give the desired form of grain distribution. Thus, in connection with the preparation of a wheel as illustrated in Fig. 2, the coating of abrasive carrying substance which is applied to the strip preparatory to winding thereof about the core may be of increased thickness along the center line of the strip; or, the strip may be painted by multiple operations involving the application of a mixture along the center line of the strip that contains a higher percentage of abrasive to the carrier employed as compared to the percentage of abrasive to the carrier employed in connection with the painting of the side edge portions of the strip.

In any case it will be seen that the object is to locate the abrasive kernels in accord with a predetermined desired manner of distribution throughout the wheel body by temporarily impounding the abrasive kernels in the component elements entering into the assembly of the abrasive wheel and subsequently fusing the elements thereof together into a unitary mass of high structural strength without substantially disturbing the distribution and relative concentration of the abrasive kernels throughout different portions of the wheel mass. Thus, it will be seen that in lieu of the spaced point type of depressions 15 illustrated in Fig. 4, the strip 12 may be prepared in any other desired manner to provide a multiplicity of interstices throughout the surface or body thereof for receiving and retaining therein the abrasive kernels in accord with a previous plan of distribution. For example, the abrasive receiving interstices of the strip 12 may be provided by any form of embossing, knurling, scratching, serrating, or other action whereby suitable forms of abrasive grain holding pockets are provided.

As explained hereinabove, the wire mesh of Fig. 3 will similarly provide a preferred form of strip 12 because of the shape of the abrasive receiving interstices which are provided between the wire strands, and various types of abrasive concentration patterns may be obtained throughout the wheel section made from such wire mesh by varying the dimensions of the wire strands and/or of the spacing therebetween, or by painting a uniform type wire mesh strip with pastes of different concentrations or with different thicknesses of an abrasive paste at different portions thereof.

Fig. 6 illustrates another form of the invention wherein a wheel structure comprises a series of discs 30 which are generally of the character of the strips 12 of Figs. 3 or 4 and disposed in side-by-side relation and pressed and fused together to form a unitary mass in the desired form of the abrasive wheel. The discs 30 may be either of wire mesh form as explained hereinabove or they may be in the form of deformed sheets, knurled or scratched or otherwise treated to provide abrasive retaining pockets therein. As in the form of the invention of Figs. 1 through 4, the discs 30 are coated with abrasive kernels in the predetermined desired manner of distribution and/or relative concentration in any given case, and the discs are then subjected to fusing temperatures and pressures as provided for by opposed die devices 35 and 36 (illustrated diagrammatically in Fig. 7). In order to provide the abrasive ingredi-

ents in concentrated form in the regions of the most active working portions of the wheel, the individual discs ultimately going into the make-up of the most active working portions of the wheel will preferably be coated with increased concentrations of abrasive as compared to the discs going into the make-up of the relatively inactive portions of the wheel. Thus, in connection with the manufacture of a V-shaped groove cutting wheel as illustrated in Fig. 6, the center discs **30** will be initially coated with greater quantities of abrasive kernels than are the discs at the opposite side portions thereof. The ridge-like peripheral form of the wheel may be obtained either by providing the discs **30** of different and appropriate diameters whereby the building up of the laminated structure will automatically provide the approximate form desired and avoid waste of expensive abrasive grains, or by using discs of equal diameters and dressing the wheel to desired form subsequent to the fusion process.

Fig. 8 illustrates another form of the invention wherein an abrasive wheel of the general type of the wheel illustrated in Fig. 6 is provided with a central reinforcing core **40**. The core may be a disc of solid steel or other suitable metal, and abrasive carrying discs **42** of the type hereinabove described in connection with the construction of the wheel of Fig. 6 are pressed and fused about the core and into the form of a unitary mass, the peripheral edge portions of the discs being arranged to extend beyond the edge of the core and to be pressed and fused together during the manufacturing process whereby an abrasive peripheral working edge will be provided. It will be understood that the working edge may be formed to the desired shape by means of subsequent dressing operations or by initially providing the discs **42** of such diameters as to combine to give the desired edge form when pressed into final position, or by any other suitable method.

It will be understood that in lieu of the specific method of wrapping the coiled strip **12** about the core **10**, as illustrated in Figs. 1 and 2 and as explained hereinabove, the annular body of abrasive containing material thereof may be initially assembled apart from the core **10** and compacted and fused into solid integral form and then mounted upon the core element **10** in accord with any suitable shop practice such as by wedging, soldering, or the like; and in such case the core **10** need not be subjected to the fusing temperatures as hereinabove described.

It will be understood that the invention is applicable with equal facility to the manufacture of a large variety of abrasive tool shapes such as are suitable for use in connection with a multiplicity of industries, and that although only a limited number of the forms of the invention have been shown and described in detail herein, various changes may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. The method of manufacturing an abrasive tool comprising essentially the steps of providing metallic sheet stock of perforated form with abrasive grains in the interstices thereof, arranging said abrasive carrying stock into a body of laminated contiguous sheet form, and heat-fusing adjacent portions of said sheet stock together.

2. The method of manufacturing an abrasive tool comprising essentially the steps of mounting abrasive granules in the interstices of a series of metallic wire mesh sheet elements, arranging a plurality of said metallic wire mesh sheet elements into a body of laminated contiguous sheet form, and heat-fusing contiguous elements of said laminated structure together to form a unitary mass.

3. The method of manufacturing an abrasive tool comprising the steps of arranging in plurality of separate perforated metallic sheet elements into a body of laminated contiguous sheet form, said sheet elements having mounted in the interstices thereof abrasive granules in accord with a definite plan of abrasive granule distribution whereby the concentration of abrasive granules is increased progressively from one sectional zone of said body to another sectional zone thereof, and heat-fusing the adjacent sheet element portions together to form a unitary mass.

4. An abrasive tool comprising laminae of metallic mesh material having abrasive mounted within the mesh thereof and secured into an integral structure by sintering.

5. An abrasive tool of sintered metallic body form comprising foraminous metallic laminae having abrasive grains mounted in the interstices thereof.

6. An abrasive wheel comprising a core and an abrasive portion integral with and disposed peripherally of said core, said abrasive portion being composed of a coiled strip of sheet metal material having pockets disposed therein in accord with a predetermined plan of pocket distribution whereby the concentration of said pockets increases progressively from one sectional zone of said strip to another sectional zone thereof, abrasive grains mounted in said pockets, said coiled strip being sintered into a unitary structure with said abrasive grains locked therein in accord with said predetermined plan.

7. An abrasive wheel in the form of a laminated structure comprising series of sheet metal disc elements in contiguous superposed relation, said disc elements having pockets therein disposed in accord with a predetermined plan of arrangement whereby the concentration of said pockets increases progressively from one sectional zone of said abrasive portion to another sectional zone thereof, abrasive grains mounted in said pockets, said disc sheet elements being sintered together into the form of a solid structure with said abrasive grains disposed therein in accord with said predetermined plan.

8. An abrasion tool comprising a coiled strip of sheet metal material having pockets disposed therein in accord with a predetermined plan of pocket distribution whereby the concentration of said pockets increases progressively from one sectional zone of said strip to another sectional zone thereof; said strip having abrasive grains mounted in said pockets, and said coiled strip being sintered into a unitary structure with said abrasive grains locked therein in accord with said predetermined plan.

9. An abrasion tool comprising series of sheet metal disc elements arranged in contiguous superposed relation, said disc elements having pockets therein disposed in accord with a predetermined plan of arrangement whereby the concentration of said pockets increases progressively from one sectional zone of said abrasion tool to another sectional zone thereof, abrasive grains being mounted in said pockets, said disc sheet elements being sintered together into the form of a solid structure with said abrasive

grains disposed therein in accord with said predetermined plan.

10. The method of manufacturing an abrasive tool comprising the steps of arranging in association with a surface portion of a foraminous metallic strip element means for temporarily mounting in fixed relation within the foramina of said strip element abrasive granules in accord with a definite plan of abrasive granule distribution whereby the concentration of said granules increases progressively from one sectional zone of said strip element to another sectional zone thereof, coiling said abrasive mounting strip to provide a wheel structure, and sintering said wheel structure into a unitary metallic body with said abrasive granules locked by sintered metal therein in accord with said definite plan of abrasive granule distribution, said granule mounting means being of such character as to be eliminated upon sintering of said structure.

11. The method of manufacturing an abrasive tool comprising the providing in association with surface portions of metallic foraminous laminae means for temporarily supporting in fixed relation within the foramina of said laminae abrasive granules in accord with a definite plan of abrasive granule distribution whereby the concentration of said granules varies with respect to different of said laminae, arranging said disc elements into the form of a single laminated structure with said abrasive granules temporarily supported by said means therewithin, and sintering the metallic portions of said laminated structure together so as to provide a unitary body with said abrasive granules locked by said sintered metallic portions therewithin in accord with said definite plan of abrasive granule distribution, said granule supporting means being of such character as to be eliminated upon sintering of said structure.

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