April 27, 1937. D. E. WEBSTER 2,078,354

ABRASIVE ARTICLE

Filed April 25, 1935

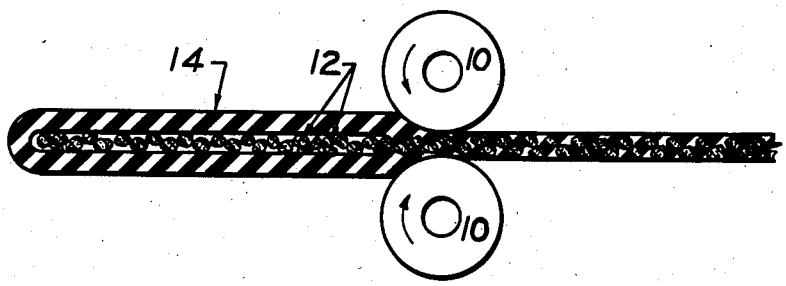

Fig. 1.

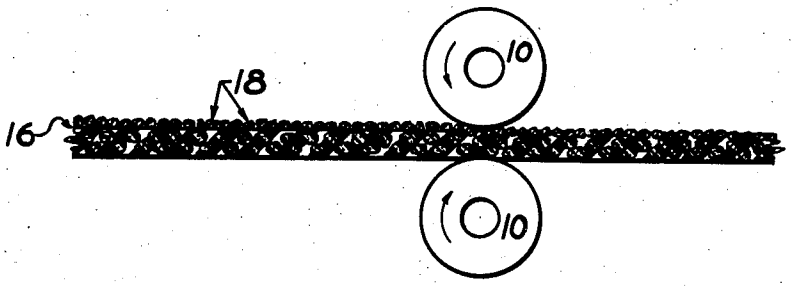

Fig. 2.

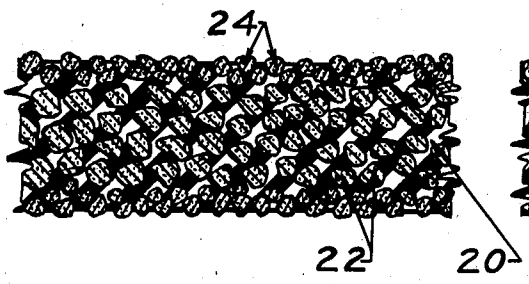

Fig. 3.

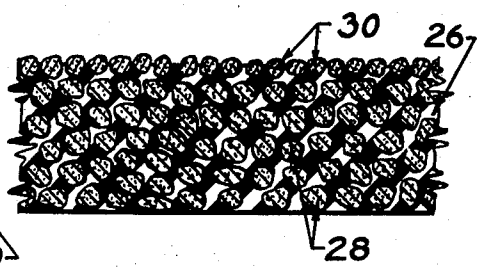

Fig. 4.

Witness
Robert G. Trumbull

Inventor
DUANE E. WEBSTER

By Clayton R. Jenkins
Attorney

Patented Apr. 27, 1937 2,078,354

UNITED STATES PATENT OFFICE

2,078,354

ABRASIVE ARTICLE

Duane E. Webster, Worcester, Mass., assignor to Norton Company, Worcester, Mass., a corporation of Massachusetts

Application April 25, 1935, Serial No. 18,211

5 Claims. (Cl. 51—278)

This invention relates to a grinding wheel, and more particularly to a thin grinding wheel adapted to act as a rotary saw for producing narrow grooves or cutting off lengths of work by providing independent but simultaneous grinding operations with its periphery and side faces.

Due to the rapid peripheral cutting ability of bonded abrasive wheels when rotated at high surface speeds, many of these wheels have been employed for cutting-off and slicing operations formerly accomplished with rotary steel saws. In fact, it has been found that a cutting-off grinding wheel of this type is capable of producing an extremely fast cutting operation even on certain alloy steels and other hard materials which cannot ordinarily be cut with a steel saw. Bonded abrasive cutting-off wheels are very thin in comparison with their diameters and they are usually 20 inches or less in diameter and ⅛ of an inch or less in thickness. These wheels are very fragile because they are thin and they cannot withstand any lateral pressure without breakage. In view of their extremely rapid peripheral cutting ability, it is frequently the practice for such wheels to be operated at as high a surface speed as 16,000 feet per minute. Breakage of a cutting-off wheel at this excessively high operating speed seriously endangers the machine operator and usually damages the work.

Heretofore, cutting-off abrasive wheels have been incapable of being operated at their maximum peripheral cutting capacities since the rapidity of the cutting operation is so great that it invariably results in an excessive heat of grinding, particularly in view of the fact that the side wheel faces were not provided with sufficient grinding ability to produce clearance between the wheel sides and the sides of the work cut during a high speed grinding operation and dissipate the heat of grinding. This excessive heat of grinding frequently causes uneven wheel expansion, resulting in warpage and breakage thereof. These wheels have also been unsatisfactory since they wear away most rapidly at their peripheral edges, with the frequent result that they become wedge-shaped and narrower at their periphery than at their central portion. A grinding wheel worn in this manner is usually discarded as unfit for use since it will not clear itself within the work cut, but will bind therein and break. Furthermore, a wheel of this type having side faces which are worn so that they taper towards each other does not produce a satisfactory cut which is perpendicular to the axis of wheel rotation.

It is, therefore, an object of this invention to provide a grinding wheel which will maintain a desired contour on its operative faces during grinding and which is adapted to simultaneously produce predetermined but different grinding effects with a peripheral face and a side wheel face.

It is a further object of this invention to provide a laminated type of cutting-off grinding wheel adapted to cut deep, narrow grooves or to cut off lengths of work, having side wheel faces of any desired grinding characteristics, irrespective of the grinding properties of the main body portion of the wheel.

It is a still further object of this invention to provide a method whereby a grinding wheel having predetermined but different peripheral and side face grinding characteristics may be easily and accurately produced.

The preferred embodiments of my invention relate particularly to a very thin grinding wheel of the type usually employed in the nature of a rotary saw for a cutting-off operation for producing deep, narrow grooves, but it will be understood that this invention is equally well applicable to any grinding wheel having different predetermined grinding properties on its periphery and a side face thereof.

According to my invention, I have provided a grinding wheel having a substantially uniformly wearing peripheral surface which will not break down rapidly on its edges nor wear wedge shaped and bind within the work cut and which will produce a fast predetermined cutting action on its opposed side faces independent of its peripheral cutting ability. This is accomplished by forming the opposed parallel side wheel faces of reenforcing surface layers of sharp abrasive grains imbedded within the sides of the body portion of the grinding wheel and thus providing surface layers having a greater quantity or density of distribution of the abrasive than has the central portion. These layers of abrasive grains may comprise any shape, size and kind of granular abrasive material irrespective of the abrasive grains employed within the main body portion of the wheel which provide the peripheral grinding properties thereof. It will thus be appreciated that my invention provides a grinding wheel having different peripheral and side wheel face grinding characteristics which may be so predetermined irrespective of each other as to each provide any desired grinding action independent of the other. The layers of abrasive grains forming the operative side wheel faces

further aid in providing the desired grinding properties on the peripheral wheel edges so that the peripheral wheel face will not break down nor change shape during a grinding operation and the wheel periphery will maintain its desired contour of grinding surface.

My preferred type of invention comprises a hard rubber bonded grinding wheel wherein an unvulcanized sheet of suitable vulcanizable hard rubber compound having abrasive grains of desired shape, size and material distributed throughout its entire body, forming a central body portion of the wheel, has a layer or coating of loose abrasive grains imbedded within its opposed sides. It should be understood that the term "hard rubber" as employed in the claims applies to a rubber compound containing at least 20% of sulphur by weight and which compound may be vulcanized to form a hard, tough, non-resilient body of the nature of ebonite or vulcanite. The abrasive grains imbedded within this central body portion of the wheel may be composed of any suitable material, such as silicon carbide or crystalline alumina, or other suitable abrasive materials or various combinations of abrasive materials adapted to provide a desired peripheral grinding operation with the grinding wheel. The abrasive material forming the granular layers imbedded within the opposed sides of the abrasive and bond forming the main body portion of the wheel may comprise any suitable abrasive, such as grains of crystalline alumina, silicon carbide, diamonds, or boron carbide known by the formula B_4C and disclosed in the United States patent to Ridgway No. 1,897,214. The abrasive material forming these surface layers and providing the additional cutting edges for the side wheel faces which supplement or increase the content of the abrasive of the main body portion of the wheel within the side wheel faces is preferably composed of a material having a different cutting ability from that of the abrasive grains within the main body portion of the wheel, and it is preferably one which provides a faster cutting action on the sides and peripheral edges of the wheel and maintains uniformly wearing grinding faces as well as to provide a sufficiently fast abrading operation on the side faces of the work cut to clear the wheel therein and provide a fast, cool cutting action.

In the accompanying drawing:

Figs. 1 and 2 illustrate diagrammatically the two successive steps of first embedding abrasive grains entirely within a mass of rubber and then partially embedding abrasive grains in a surface thereof; and

Figs. 3 and 4 show fragments in section and greatly enlarged of two types of wheel made by this method.

In the manufacture of my preferred type of cutting-off grinding wheel, abrasive grains of suitable size, shape and material, such as crystalline alumina or silicon carbide, are incorporated in a sheet of suitable vulcanizable hard rubber compound by any well-known milling process, as indicated diagrammatically in Fig. 1 of the drawing. For example, the raw rubber bonding material commonly referred to as smoked sheet may be first compounded by repeatedly passing the rubber and compounding materials, such as sulphur, and suitable fillers, vulcanization accelerators etc. between heated spaced rotating rolls 10. The rubber sheet containing the compounding materials may be folded after each successive pass through the rolls until the rubber and compounding materials are intimately mixed throughout the entire body. The sulphur content of this vulcanizable rubber compound preferably comprises 20% or more by weight relative to the weight of the raw rubber compounded therewith, so that the resultant product will form a hard rubber when vulcanized.

A required quantity of loose abrasive grains 12 of desired size, material and shape is thereafter wrapped in the sheet rubber compound 14 and the resultant body is milled by repeatedly passing it between the same set or a similar set of heated rolls 10 until the abrasive material is uniformly distributed throughout the entire sheet, as indicated at the right hand portion of the rubber mass in Fig. 1. These rolls are adjustably spaced relative to each other and are usually moved closer together after each successive pass of the rubber sheet therebetween until it is of the final desired wheel thickness. When the abrasive grains have become suitably distributed throughout the entire body of unvulcanized rubber compound, the top face of the rubber and abrasive sheet 16 (Fig. 2) is coated with an evenly distributed layer of loose abrasive grains 18. These grains are of desired shape and material to provide a required grinding operation by the side faces of the cutting-off grinding wheel, and they preferably comprise a harder abrasive material than that of the abrasive grains within the central body portion of the wheel. The coated rubber sheet is passed back and forth through the milling rolls 10 a sufficient number of times to thoroughly imbed the layer of surface grains within the side face of the rubber and abrasive sheet and reduce the body to the desired thickness.

As shown in Fig. 3 this type of cutting-off grinding wheel comprises a main body portion 20 of hard rubber carrying abrasive grains 22 of alumina having a grit size of 150, and the side wheel faces are composed of embedded layers of a harder abrasive 24 of a suitable size, such as silicon carbide or boron carbide of 180 grit size. Another example of my cutting-off wheel comprises a central body portion of rubber bonded silicon carbide grains of 90 grit size and side wheel faces composed principally of embedded layers of granular boron carbide of 240 grit size. Various combinations of abrasive materials of various grit sizes may be employed, but the embedded abrasive layers forming the opposed side wheel faces are preferably composed of a harder abrasive material and of a smaller grit size than that of the abrasive grains within the main body portion of the wheel. The depth of the layer of embedded grains forming the side wheel faces may be predetermined by controlling the thickness and number of layers of loose abrasive material rolled into the surface of the raw rubber sheet. The rubber sheet is then turned over and is similarly coated and impregnated with another layer of abrasive grains on its opposed side face, after which disk shaped grinding members of desired outer and inner diameters are cut therefrom by means of suitable dies and thereafter subjected to any suitable vulcanizing operation, such as a heat of 250° C. for several hours, as is well known in the art.

It will be appreciated that in this type of grinding wheel, side faces may be provided having any desired cutting ability independent of the cutting ability of the main body portion of the wheel which determines the peripheral grinding characteristics thereof. Furthermore, as

shown in Fig. 4, a grinding wheel comprising a body of rubber 26 and abrasive grains 28 may have only one rough side face, which may be easily provided in the same manner by simply impregnating a layer of loose abrasive grains 30 in one side of the unvulcanized sheet of rubber compound.

Various modifications in structure and methods of manufacture of the present invention will be apparent to one skilled in the art, and the claims presented in this case are to be interpreted broadly within the scope of my disclosure.

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

1. A grinding wheel having a peripheral cutting face and comprising a body of abrasive grains distributed in and bonded solely by vulcanized rubber and having a side layer of supplemental abrasive grains embedded in the rubber and abrasive body and solely bonded by the rubber thereof.

2. A grinding wheel having a peripheral cutting face and comprising an inner body of abrasive grains interspersed substantially uniformly throughout a bond of vulcanized hard rubber, and outer layers of supplemental closely spaced abrasive grains distributed on the side faces of the wheel and partially embedded in the rubber and abrasive body and bonded solely by the rubber thereof, whereby the side faces of the wheel have a greater density of abrasive grains than has the inner body.

3. A grinding wheel according to claim 1 wherein the supplemental abrasive material in the side layer has an average grain size which is materially different from that of the abrasive grains of the body portion.

4. A grinding wheel according to claim 1 in which the supplemental abrasive grains on the side faces are harder than the grains in the inner body.

5. A grinding wheel according to claim 1 in which the supplemental abrasive grains on the side faces comprise boron carbide and the grains within the body portion are of a softer abrasive material.

DUANE E. WEBSTER.