

[54] **CUT-OFF WHEELS OF FUSED
ALUMINA-ZIRCONIA ALLOY ABRASIVE
GRAINS**

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Related U.S. Application Data

[63] Continuation of Ser. No. 204,373, Dec. 2, 1971,
abandoned.

[52] **U.S. Cl.**..... **51/298; 51/309**

[51] **Int. Cl.²**..... **C09K 3/14**

[58] **Field of Search**..... **51/298, 309**

[56] **References Cited**

UNITED STATES PATENTS

3,156,545	11/1964	Kistler.....	51/298
3,175,894	3/1965	Foot.....	51/298
3,181,939	5/1965	Marshall et al.....	51/309
3,524,286	8/1970	Wohrer.....	51/298
3,607,162	9/1971	Bockstiegel et al.....	51/309

FOREIGN PATENTS OR APPLICATIONS

878,433	8/1971	Canada.....	51/298
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OTHER PUBLICATIONS

Federal Register, Dept. of Labor, Vol. 36, No. 105,
Part II, May 29, 1971, pp. 10629, 10630.

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Attorney, Agent, or Firm—Rufus M. Franklin

[57] **ABSTRACT**

Circular abrasive blades, known as cut-off wheels, are made faster cutting and more durable by employing fused, fine grained, alumina-zirconia abrasive grits, containing 10 to 60% and preferably 20 to 50% zirconia, having an elongated shape corresponding to a bulk density for 25% zirconia material having a specific gravity of 4.35, in the 24 grit size, of not more than 135 pounds per cubic foot, as at least 25% by volume, of the abrasive in the wheel.

This invention relates to the class of relatively thin grinding wheels used for cutting metal, such as for cutting the gates and risers from ferrous castings, known in the art as cut-off wheels, and in particular it relates to improving the performance of such wheels by the employment in such wheels of fused alumina-zirconia abrasive grits of particular composition and shape.

4 Claims, No Drawings

CUT-OFF WHEELS OF FUSED ALUMINA-ZIRCONIA ALLOY ABRASIVE GRAINS

This is a continuation of application Ser. No. 204,373, filed Dec. 2, 1971 and now abandoned.

FIELD OF THE INVENTION

This invention relates to cut-off wheels which are used for the slicing or parting of a material or part, and are subject, under the Occupational Safety and Health Standards Act Rules and Regulations (see secs. 1910.211, published in the Federal Register of May 29, 1971, page 10,630), to the following maximum thickness limitations:

Wheel Diameter	Maximum Thickness
6" and smaller	3/16"
Larger than 6" to 12"	1/4"
Larger than 12" to 23"	3/8"
Larger than 23"	1/2"

As used in this specification and claims, the term cut-off wheel (or synonymously cutting-off wheel) means wheels complying with the O.S.H.A. Rules and Regulations published May 29, 1971, in the Federal Register.

BACKGROUND OF THE INVENTION

The standard abrasive grain commercially employed in cut-off wheels for cutting-off ferrous metals, has been the standard or regular fused alumina produced by the electric arc furnacing of bauxite and having an alumina content of about 95%. Such abrasive is available in so-called strong blocky shapes, and in weaker, slivery shapes. The preferred grain for the cut-off wheels has traditionally been the blocky, strong shaped grain. When weak shaped grain is substituted in the wheels, the rate of cut, under very light pressure cutting-off may be increased, but the durability of the wheels under all cutting conditions is reduced, resulting in an uneconomical grinding operation.

The use of microcrystalline fused alumina grits in cut-off wheels, as opposed to the essentially monocrystalline abrasive employed as the standard, has not achieved commercial success. Although more durable than the standard alumina grits, such grits result in wheels having a lower rate of cut than when the standard alumina grit is employed, which is not sufficiently offset by increased durability for economical operation.

Recently the fused alumina-zirconia alloy abrasives have come on the market. Such abrasives are more tough and durable than prior art fused alumina abrasives and have been employed extensively in heavy duty snagging grinding applications such as the cleaning of steel billets and the heavy duty snagging of ferrous metal castings. Such abrasives have been employed, almost exclusively in the form of strong, blocky shaped grains, although recently they have been found to be useful in weaker shapes for the manufacture of coated abrasives.

Until the present invention, the alumina-zirconia alloy type abrasives have not been employed commercially in cut-off wheels.

SUMMARY OF THE INVENTION

Significantly improved grinding efficiency has been achieved according to the present invention by employing weak shaped alumina-zirconia alloy abrasive grits in thermoset or infusible resin bonded cut-off wheels.

U.S. Pat. No. 3,181,939, discloses microcrystalline alumina-zirconia fused alloy abrasives containing from 10 to 60% zirconia. The finding of the present invention is that the more finely microcrystalline materials of this type, when produced in slivery or weak shaped grain significantly improve the grinding efficiency of thermoset resin bonded cut-off wheels in which they are incorporated.

Slivery or weak shaped grain of the desired size is produced by the rolls crushing of material of coarser grit size than required, followed by screening.

Best results are achieved with 100% of the abrasive of the alumina-zirconia alloy type. However up to 75% by volume of the abrasive may be replaced by blocky shaped fused alumina, and improved results achieved according to the present invention. Such substitution may be advantageous to reduce the cost of the wheel.

Although operative in the range of 10 to 60% zirconia, the preferred abrasive for the present invention contains from 20 to 50% zirconia. The microcrystallinity of the abrasive should be such that the diameter of the primary alpha alumina crystals is less than 40 microns. Such abrasive can be produced by the methods disclosed in U.S. Pat. No. 3,181,939, and British Patent 1,233,997, teaches one method of rapid cooling to achieve the preferred microcrystallinity.

Rolls crushing of the abrasive results in elongated grits which pack more loosely than strong shaped, more equidimensional grits. Useful abrasive grits are those selected from a population, for a 25% zirconia product having a specific gravity of 4.35, in which the 24 grit sized material (U.S. Dept. of Commerce Standards) has a loose packed (or bulk) density of not more than 130 pounds per cubic foot (2.1 grams/cc). For grain from the same population the bulk density decreases with finer grit sizes and increases with coarser grit sizes. For the purpose of this invention, a grain processing which results in a weight per cubic foot for the 24 grit fraction of not more than 135 pounds per cubic foot will be satisfactory. Although a precise lower limit has not been determined, lower densities, in the 24 grit fraction, than 115 pounds per cubic foot, would not be practical, for the 25% zirconia material. For material containing other than 25% zirconia or for 25% material having a specific gravity other than 4.35, the maximum and minimum bulk density should be corrected by multiplying 135 by the ratio of the specific gravity of the material to the specific gravity of the 25% material (4.35).

To achieve best results, the abrasive should be bonded with a phenol-aldehyde thermoset bond, with high bond content and high abrasive content, the abrasive ranging from 48 to 56 volume percent, and bond from 22 to 50% by volume, with any remainder being pores.

SPECIFIC EMBODIMENTS OF THE INVENTION

Example I

An example of the new wheel is a 20 × 5/32 × 1 inch (20 inch diameter, 5/32 inch thick, 1 inch diameter hole) No. 24 1910.211, grit reinforced resinoid bonded

product. A typical use for this wheel is for foundry cutoff work. This wheel has the glass fabric construction of standard commercial products.

A. Materials	
1. The Mix	
7.46 lbs.	24 grit abrasive (25% zirconia, average size of primary alumina crystals 20 to 40 microns in diameter, 4.35 sp. gr.)
.97 lbs.	5417 powdered phenol-formaldehyde resin (from Union Carbide Corp.)
.32 lbs.	9332 liquid phenol-formaldehyde resin (from Union Carbide Corp.)
1.25 lbs.	No. 320 mesh and finer iron pyrites filler
10.00 lbs.	Total

19 cc of Carbosota, a neutral anthracene oil wetting agent sold by Barrett Division of Allied Chemical Company, is also used with the above ingredients. The mix is made in the conventional way. The powdered resin and pyrites are batched together before adding to the mixing machine.

The bulk density of the abrasive was 123 to 126 pounds per cubic foot.

2. Resin Coated "RC" and "RC" 22 glass fabric

This wheel is molded with two layers of mix and one full diameter resin coated RC 35 glass in the center of the wheel. A piece of 14 inch diameter RC 22 glass is molded onto each side of the wheel. These two styles of glass are impregnated with a phenol-formaldehyde varnish. The coated fabric contains approximately 33% by weight resin and 67% by weight glass.

Style 35 glass has 3.5 × 3.5 mesh and a weight of 11.2 oz./sq. yd. Strength is approximately 560 pounds per inch width. Style 22 glass has 2 × 2 mesh and a weight of 7.1 oz./sq. yd. Strength is approximately 355 pounds per inch width.

The resin coating on the glass is dried to a volatile of 3 - 5%. In this form the fabric is limp but not sticky. Industrial Polymers & Chemicals Inc., Shrewsbury, Mass. is one supplier of style 35 and 22 glass.

3. A piece of thin paper is used on each side of the wheel in molding. This paper is used to help release the "green" wheel from the polyurethane surface on the steel mold plate.

B. Filling the Mold

A 20 1/4 inch diameter × 1 inch hole cut-off mold with rough sided steel plates is placed on a turn table. A piece of 20 inch paper is first placed on the bottom mold plate and then a sheet of 14 inch diameter × 1 1/4 inch hole RC 22 glass is placed on top of the paper. The turn table is started and 2.2 pound of mix is poured in and spread level. The full diameter RC 35 glass is added after which the second layer of 2.2 pounds of mix is added to the mold and spread level. Next the second sheet of 14 inch diameter RC 22 glass is placed on top of the second layer of mix. Finally the second layer of paper is placed on top of the 14 inch diameter RC 22 glass. To keep the wheel from warping it is important that the glass fabric discs be oriented. By oriented we mean that the warp direction of all glass discs be placed in the same direction.

The top plate is placed in position and the mold is given 1100 tons pressure (3.4 tons per sq. in.). The wheel is then stripped from the mold.

C. Baking Wheels

The green wheels are set in a conventional method which is batt, wheel, batt, wheel, batt etc. approximately 25 wheels high. 650 pounds of dead weight is

put on top of the stack of wheels and batts during the bake to help produce a well knit structure of glass and abrasive mix. The wheels are baked at a top temperature of 160°C for 6 hours.

For comparison purposes wheels were made identical to the above except that the abrasive was a blocky shaped standard or regular fused alumina (95% Al₂O₃) grit having a bulk density of 127 to 131 pounds per cubic foot. This is a standard commercial abrasive, prior to the present invention, for the tested application.

METHOD OF TEST

A standard commercial cut-off saw was employed (Tabur), wheel speed was 2400 revolutions per minute, manual plunge cuts at 20 KWH indicated power were taken on 2 inch diameter nodular iron bars, five cuts per measurement.

RESULTS

The invention wheel employing the rolls crushed zirconia-alumina alloy abrasive wore only 16.6% as much as the standard wheel while making twice the number of cuts. The time per cut was 4.1 seconds for the standard and 3.5 for the wheel of the invention.

Although the test results refer to 24 grit abrasive similar improvement is achieved in the useful grit range for cut-off wheels, normally from 12 grit through 36 grit sizes.

The "weight per cubic foot" values employed herein are determined by the following method. A calibrated cylindrical container 4 inches in diameter and 15 13/16 inches high, and having a volume as close as possible to 3447 cubic centimeters, is clamped to a heavy steel disc. The disc is mounted in a holder and plate and container are jolted by a cam at the rate of 100 jolts per minute, with a free fall of 5/64 inches. A hopper is mounted above the top of the calibrated can. An amount of grain in excess of the calibrated content of the cylinder is placed in the hopper. A gate in the bottom of the hopper, uncovering an opening three-fourths inch in diameter is opened and the jogging of the cylinder is simultaneously started. The cylinder is allowed to fill and is kept full during the jolting. The jolting is continued for 590 jolts, and the excess grain is scraped from the top of the cylinder with a straight edge. The weight per cubic foot is then determined by weighing the contents of the cylinder, which has previously been precisely calibrated as to volume.

What is claimed is:

1. A cut-off wheel of abrasive grains with a grit range of 12-36 bonded by an infusible resin bond, said wheel having maximum thickness as defined below:

Wheel Diameter	Maximum Thickness
6 inches and smaller	3/16 inch
larger than 6 inches to 12 inches	1/4 inch
12 inches to 23 inches	3/8 inch
larger than 23 inches	1/2 inch;

said wheel characterized in that at least 25% by weight of the abrasive content is a fused alumina-zirconia alloy abrasive having a zirconia content between 10 and 60% by weight, an average primary alpha alumina crystal diameter less than 40 microns, and an elongated shape such that its bulk density in the 24 grit size range is in the range of from:

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115 times s.g./4.35, to 135 times s.g./4.35, pounds per cubic foot, where s.g. is the specific gravity of the abrasive grit material, said wheel containing from 0-75% by weight of blocky fused alumina grit.

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- 2. A cut-off wheel as in claim 1 in which the fused alumina-zirconia grit has a zirconia content of between 20 and 50 weight percent.
- 3. A cut-off wheel as in claim 1 in which the bond is a phenol-formaldehyde resin, and the zirconia content of the abrasive is 25 weight percent.
- 4. A cut-off wheel as in claim 3 including up to 75% by volume of blocky fused alumina grits.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,916,583 Dated November 4, 1975

Inventor(s) Robert A. Rowse and Hussain G. Lakhani

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 65: "No.241910.211" should read

-No. 24 -

Column 4, line 51: after "grit" the word - size -
should be inserted.

Signed and Sealed this

ninth Day of March 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

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Commissioner of Patents and Trademarks