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ABRASIVE ARTICLES

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The invention relates to abrasive articles and more particularly to grinding wheels.

One object of the invention is to provide an active filler for grinding wheels and other abrasive products, particularly for organic bonded products, which improves the quality thereof. Another object of the invention is to provide a filler with a higher quality number Q where

$$Q=K\frac{M^2}{W}$$

where K is a constant, M is material removed and W is wheel wear. Another object of the invention is to provide a filler which gives a higher ratio of material removed to wheel wear. Other objects will be in part obvious or in part pointed out hereinafter.

Efficiency of grinding wheels has sometimes in the past been stated in terms of ratio of material removed to wheel wear. This quite accurately gives the economy of grinding so far as the cost of abrasive is concerned, if like quantities of abrasive are assumed to cost like amounts. But let us assume two wheels having the same ratio in a given grinding job but where the material removed by wheel A in a given time is twice that removed by wheel B in the same time. Clearly wheel A is commercially preferable for such job because the labor cost and overhead are half of that for wheel B. No one formula for determining the most economical wheel under all conditions of labor cost and overhead can be devised. It happens, however, that the expression

$$\frac{M^2}{W}$$

measures the economy of grinding wheels in many grinding operations providing a large allowance for labor cost and also for overhead. It can be generalized that in most dry snagging operations the true economy is an expression.

$$\frac{M^n}{W}$$

where n is a number between 1 and 2. In the formula

$$Q=K\frac{M^2}{W}$$

the constant K is used simply to make the figures approximate some figures derived from earlier formulae and so, for relative results it can be ignored. It follows that in a comparison of fillers in otherwise identical grinding wheels grinding

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under the same conditions, one which gives a higher Q number where

$$Q=K\frac{M^2}{W}$$

and which also has a higher ratio where

$$\text{ratio}=\frac{M}{W}$$

is a superior filler for most dry snagging operations.

In accordance with my invention I have found that the quality and economy of abrasive articles, and particularly grinding wheels, may be materially improved by incorporating therein the combination of potassium fluoborate (KBF_4) and iron sulphide such as troillite (FeS) or pyrites and marcasite (FeS_2). Each of these has previously been used. In my Patent No. 2,308,981 there is described and claimed a filler of iron sulphide. In my Patent No. 2,308,983 there is described and claimed an alkali metal fluoborate specifically potassium fluoborate. Of these two fillers potassium fluoborate was found to be superior for most snagging operations. I have now made the surprising discovery that the use of both of these fillers in combination gives better grinding results as measured both by quality number Q and by ratio of material removed to wheel wear than the use of either of them alone. This indicates that there may be some interaction between the two compounds and iron or steel being ground which is different from the action of either of them on the iron or steel being ground or the sum of such actions. Otherwise it would seem to be clear that the mixture of the two fillers would produce a result which is the mean of the results produced by these fillers alone.

The filler of the invention has been used in grinding wheels for snagging operations consisting of fused alumina abrasive bonded with phenol formaldehyde bond. The manufacture of such grinding wheels is now well known and for the general procedure reference may be had to either of the above patents. Other abrasives may be used such as silicon carbide and other bonds such as rubber or synthetic rubber and the combination filler of this invention may be introduced into the pores of a vitrified ceramic bonded grinding wheel.

Five wheels were made from No. 12 grit size Al_2O_3 bonded with phenol formaldehyde, all wheels being 16" in diameter by 2" thick with a 6" diameter central hole. In accordance with

the usual practice the abrasive grains were first wet with furfural, then reactive A stage phenol formaldehyde was added containing 4% by volume of the bond and filler of CaO as a dehydrating agent. These wheels contained different fillers, which were mixed with the bond. The structure of these wheels was identical, namely 58 volume per cent of abrasive and 26 volume per cent of bond, leaving 16 volume per cent of pores. The wheels were then tested under identical conditions with a swing frame grinder grinding 18—8 Allegheny steel with 140 pounds of total pressure between wheel and work at a speed of 9500 surface feet per minute.

Table 1 gives the wheel number, the filler and percentage thereof by volume of the total bond and filler, the wheel wear in cubic inches per hour W, the material removed in pounds per hour M; the quality number as represented by the expression

$$K\frac{M^2}{W}$$

the ratio of material removed to wheel wear

$$\frac{M}{W}$$

and a designation of the day on which the grinding was done.

Table 1

Wheel number	Filler	W	M	$K\frac{M^2}{W}$	$\frac{M}{W}$	Day
074	21% cryolite	10.7	9.3	14	0.869	No. 1
098	do	12.8	10.6	16	.828	No. 2
085	do	13.5	11.3	17	.837	No. 2
874	21% FeS_2	10.8	9.1	14	.843	No. 1
102	21% KBF_4	13.0	12.0	20	.923	No. 2

Seven wheels were made to a size 16" in diameter by 2.5" thick with a 6" diameter central hole out of No. 12 grit size Al_2O_3 which was first wet with furfural after which reactive phenol formaldehyde resin containing 5% CaO by volume on the total bond and filler was added. These wheels were tested under identical conditions in a swing frame grinder grinding bullet steel with a total pressure of 175 pounds between the wheel and the work and at a speed of 9500 surface feet per minute. The wheels had different fillers as indicated in Table 2, the headings whereof have the same meaning as in Table 1. All these wheels had the same structure namely 54 volume per cent of abrasive, 34 volume per cent of bond including filler and the lime, leaving 12% pores.

Table 2

Wheel number	Filler	W	M	$K\frac{M^2}{W}$	$\frac{M}{W}$	Day
XL276	25% cryolite	30.0	18.3	20	0.610	No. 3
XL1139-1	do	24.7	17.9	23	.725	No. 4
XL1139-2	do	24.2	17.4	22	.719	No. 4
XL278	12.5% cryolite+12.5% KBF_4	30.0	19.3	22	.643	No. 3
XL11341	12.5% cryolite+12.5% KBF_4	26.2	18.2	23	.695	No. 4
XL277	12.5% FeS_2+12.5% KBF_4	29.2	22.1	30	.757	No. 3
XL11340	12.5% FeS_2%12.5% KBF_4	23.0	20.2	32	.878	No. 4

Evaluating the figures in Table 1 and Table 2 it is seen that whether evaluated by quality number or by ratio of material removed to wheel wear, FeS_2 for grinding stainless steel is no better than cryolite. It also appears that for grinding stainless steel potassium fluoborate is superior to either cryolite or FeS_2. On the other hand the combination of cryolite and potassium fluoborate is no better than cryolite for grinding bullet steel. And the combination of FeS_2 and potassium fluoborate is definitely superior to cryolite for the grinding of bullet steel. Furthermore, as measured by the quality number

$$K\frac{M^2}{W}$$

the margin of superiority of FeS_2 plus KBF_4 over the standard filler cryolite is greater than the margin of superiority of KBF_4 over cryolite.

For the manufacture of grinding wheels bonded with other bonds one may proceed as explained in my Patents No. 2,308,981 and 2,308,983 which describes the manufacture of grinding wheels bonded with aniline formaldehyde, with rubber, and the manufacture of vitrified grinding wheels.

In the case of any organic bonded wheel the filler of this invention, KBF_4+iron sulphide, is incorporated in the bond. In the case of a vitrified grinding wheel, the wheel is first made in the usual manner and then the pores thereof are impregnated with the filler suspended in a supplemental bond, all as fully explained in each of Patents No. 2,308,981 and 2,308,983.

It will thus be seen that there has been provided by this invention grinding wheels and other abrasive articles in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. An abrasive article comprising abrasive grains, a bond uniting the grains as an integral body, and the combination of iron sulphide and potassium fluoborate interspersed throughout the bonded mass.

2. An abrasive article comprising abrasive grains, an organic bond uniting the grains as an integral body, and filler of finely divided solid iron sulphide and potassium fluoborate interspersed throughout the bond.

3. An abrasive article comprising abrasive grains and a resinoid bond which unites the grains as an integral body, said bond having intimately associated therewith filler comprising iron sulphide and potassium fluoborate.

4. An abrasive article comprising abrasive grains and a phenol formaldehyde bond which unites the grains as an integral body, such bond having intimately associated therewith filler comprising iron sulphide and potassium fluoborate.

5. An abrasive article comprising abrasive grains, an organic bond uniting the grains as an integral body, and a filler comprising a combination of FeS_2 and KBF_4.

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