APPARATUS AND PROCESS OF MAKING ABRASIVE TOOLS

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APPARATUS AND PROCESS OF MAKING ABRASIVE TOOLS

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This invention relates to processes and apparatus for producing abrading devices of the non-flexible type, such as wheels, blocks and the like, which are formed by bonding abrasive grains in a mass.

Abrasive materials, such as corundum, emery, artificial corundum, crystalline alumina, carbide of silicon, and other well known forms of granular abrasives, are usually composed of irregularly shaped grains, a substantial proportion of which are of distinctly elongated formation, so that one dimension thereof is longer than the others, the presence of elongated grains in large proportion being particularly apparent among grains of the larger sizes, such as are usually employed in the construction of abrasive devices which are to be used for rough work. Abrasive grains of elongated formation necessarily have correspondingly flattened sides, which are much less effective, when engaged with the work, than the ends thereof, even though the ends may not be sharply pointed, or knife edged. Abrasive grains of this character are usually mixed with grains of more nearly cubic formation, which softened or fused when subjected to heat, then to place the mixture in a mold of the shape desired and subject the mass to considerable pressure, so that it is compressed into a cake, which is then baked, causing the bond to become softened or fused, so that, when it hardens, on cooling, the grains will be firmly bound together.

In performing this process, the grains of abrasive have been fixed in the bond in practically the positions in which they chance to fall, when placed in the mold, so that, while some of the elongated grains are likely to lie in approximately perpendicular relation to the work engaging face of the tool, much the greater proportion thereof are likely to lie with their sides either in parallel relation to the face, or at various angles between parallel and perpendicular positions relative thereto. As this condition obtains throughout the mass, it follows that it is indicative of the condition of the work engaging face at any time.

The cutting effect of which an abrasive tool of any given grit size is capable, or the extent to which it is free cutting depends to a large extent on the multiplicity of its cutting points, or the number of cutting points which it has in its abrading surface per unit of area thereof, and, as it is usually desired that an abrading tool be as free cutting as possible, any condition which increases the number of the cutting points in its abrading surface, without detrimental effect otherwise, is desirable, as it increases its efficiency. If the elongated abrasive grains in an abrading tool lie mainly flatwise to its abrading surface, it follows that the number of the cutting points in said surface, and therefore the cutting effect of the tool, will be less than that of a tool in which the elongated grains lie mainly in an approximately perpendicular relation to the surface, and if the abrasive grains which are not distinctly elongated, but are of more nearly cubic formation, are arranged so that the number of cutting points per unit of area in the surface are increased, a corresponding increase in the efficiency or cutting effect of the tool will be secured.

In other words the sharp or pointed ends of the grains have a much greater cutting effect than the sides thereof as the sides present practically flat, or nearly flat surfaces to the work, or points whose included angles are relatively large, so that their action is more nearly a rubbing action which dislodges small particles, than a distinctly cutting or severing action. Moreover, an action, which is more distinctly a rubbing action, has a much greater tendency to cause heat than a cutting action, on account of the fact that the friction is much greater in removing a certain amount of material than it would be if removed by an action which severs.

Where the abrasive grains are largely of elongated formation, and are poured into the mold in the customary manner, the grains lie criss-cross and leave many unfilled spaces, resulting in a tool which lacks solidity and uniformity in its construction. Tests have shown, and it is well known to manufacturers of abrasive tools, that the durability of such tools, and the length of service which they will give, depends on a substantial extent on their weight per unit of volume, or the density of the structure which they form. In consequence it has been the practice to subject the elongated grains to further treatment to reduce them to a more nearly cubic, bical, or polyhedral form, so that the density of structure would be increased and each grain would present a correspondingly large number of sharp points, one of which would be likely to form a part of the working face of the tool.
This further treatment necessary to produce cubical, or polyhedral grains, increases the cost of the abrasive, as compared with the elongated grains before referred to.

The primary object of my invention is to produce an abrading device or tool which will have a substantially increased efficiency, as compared with the efficiency of devices of this character which are made by the methods now generally employed.

Further objects of my invention are to produce an abrasive tool which may be formed largely, or wholly of abrasive grains which are of elongated formation, but which will be practically as solid, or free from spaces between the grains as when formed from grains of the cubical or polyhedral type, so that the less expensive forms of abrasives may be employed, and, at the same time, a tool may be produced which will have increased durability, more effective clearance at the cutting points, and an increased number of cutting points in the working face, so that the efficiency thereof will be substantially increased, as compared with tools formed from grains of the cubical, or polyhedral type.

I accomplish these objects by producing an abrading device which is principally composed of abrasive grains of elongated formation, so that one dimension is substantially longer than the others, and by arranging said grains so that they lie side by side and are packed closely together, with their longer dimensions extending in approximately perpendicular relation to the working face of the tool, or in radial relation thereto when the tool is of the wheel type and has a circular face, said grains being securely bonded in these positions, so that their ends will be presented to the work and they will have deep settings which will prevent them from being dislodged in use.

Inasmuch as the arrangement of the grains of which a tool is formed in any particular manner before bonding, by any mechanical means, is, so far as I am aware, practically impossible, and must be secured, if at all, at but slight increase in manufacturing expense, so that the advantages secured will not be nullified by the expense of manufacture, a further and quite equally important object of my invention is to provide a commercially practical process of producing abrading devices of the character above referred to, in which the mass of elongated abrasive grains of which a particular device is formed will be mainly positioned in approximately perpendicular relation to the working face of the device, and grains of more nearly cubical formation will be mainly positioned with their more pointed portions projecting towards, or into the working face thereof.

I accomplish this object, primarily, by producing within the mold in which the tool is to be formed a magnetic flux, which acts to polarize the abrasive grains, as the latter are placed therein, so that the pointed ends of the grains will be magnetically attracted in a particular direction and a large portion of the grains will be turned into positions in which said ends will be pointed towards the abrading face of the tool.

Practically all abrasive grains which are at present in use are non-magnetic and consequently will not be either attracted or repelled by a magnetic field. Such grains may be influenced by an electrostatic field, but such a field causes the grains to have a repellent effect on each other, so that if the grains were showered into a mold through an electro-static field, while they might be temporarily influenced to point in a certain direction, the grains would come into contact with each other in the mold there would be an electrical discharge from one to another, which will instantly nullify any positioning effect which had been secured.

A further object of my invention therefore, is to provide a process whereby non-magnetic abrasive grains may be positioned by means of a magnetic flux and I accomplish this object primarily by providing the grains with a thin coating of iron dust, which is adhesively secured thereto, so that they become magnetically responsive.

In the practical application of this process, I produce a magnetic field within the mold in which the tool is to be formed, the lines of force of which are directed approximately perpendicularly to the abrading face of the tool to be formed, so that the grains when showered into the mold, or placed therein in successive layers, will be polarized and caused to be turned into positions in line with the lines of force by which they are effected, or to be turned into positions in which the positively influenced magnetic pole of practically each grain will be nearest the negative pole of the magnet which generates the field and the negatively magnetized end thereof will be nearest the positive pole of the magnet, and will be held in this position until the mass is compressed and bonded.

Also in connection with the operation of polarizing and distributing the grains of abrasive in the mold, or other means in, or on which the grains are positioned before bonding, I provide means for assisting or facilitating the effect of the magnetic, or electrostatic action, in tending to turn the grains so that they will point mainly in one direction, by providing means for imparting a slight jarring action to the container into which the grains are delivered.

For a more complete descriptive statement of the invention and of the means by which it may be performed, reference is now made to the accompanying drawings, in which:

Figs. 1 and 2 are front and side elevations of one form of combined electromagnetic and mechanical apparatus which is preferably employed in performing certain portions of the heretofore described and in the construction of a certain type of abrasive tool.

Fig. 3 is a sectional view on line 4—4 of Fig. 2. Figs. 5 and 6 are respectively plan and sectional views indicating a modified form of apparatus which may be employed in making an abrasive tool of another type.

Figs. 7 and 8 are respectively plan and sectional views indicating another form of apparatus which may be employed in making another type of tool.

Fig. 9 is a detail view indicating an abrasive tool made according to my invention.

As a preliminary step in the method, the abrasive grains are thoroughly mixed with a suitable bond, and in connection with this step the abrasive grains, when of non-magnetic material, as usual, are coated with a form of magnetic dust, a ferrous dust such as powdered steel being preferably attracted or repelled in several different ways, all of which are considered to be within the scope of my invention.
Certain bonds or binders which are frequently employed are of a somewhat adhesive nature, as for example certain forms of synthetic resins, which become adhesive when slightly heated and which preferably is of yoke form, and a vertical shaft 11 is journaled in bearings 12 and 13 there-in, a shoulder or step bearing collar 14 being provided on said shaft which rests on the upper end of the bearing 12. The lower end of the shaft extends beneath the lower end of bearing 12 in position to be struck on its end by a pneumatic hammer 15, which is placed directly beneath said shaft, so that a slight upward movement of the latter may be caused, permitting corresponding impact when it descends, for purposes to be explained. An insulating plate 16 is mounted on the top end of the shaft 11 and is provided with a circular horizontal top face and a flat circular wrought iron plate 17 is mounted thereon. Two series of circularly and concentrically arranged magnet cores 18 and 19 are mounted vertically in said plate 17, the upper ends of the outer series of cores 18 being fitted into aperture formed in a wrought iron ring 20 and the inner series being likewise fitted into a similar ring 21, said rings being concentrically arranged and providing a space between their adjacent inner and outer peripheries adapted to receive a mold for forming the annulus to be produced, the thickness of the rings corresponding to the thickness thereof. In case the hole in the annulus to be formed is small, the cores 19 and ring 21 may obviously be combined in a single cylindrical post.

The cores 18, 19 are wound with wire in series so that the ring 20 will form one pole of an electromagnet and the ring 21 will form the other pole thereof, the plate 17, forming the intermediate part of the magnet, so that when a direct-current is passed through the winding of the rings 20 and 21 will be oppositely polarized. As the inner peripheral face of the ring 20 and the outer peripheral face of the ring 21 are the portions thereof in closest proximity, the magnetic field or flux between the poles will be formed principally between these faces, and the lines of force will extend radially with relation to the center of rings 20, 21. The arrangement of the parts and windings is such that the electromagnetic force of the two rings will be as nearly equal as possible, to reduce loss from leakage.

A mold or receptacle, with suitable means for supporting the same, is provided between the rings 20, 21, the means illustrated comprising a series of non-magnetic metal posts 22 mounted on insulating bases 23, on the plate 17 and a flat annular base ring 24 of similar material, which is supported on the upper ends of said posts and forms a horizontal support for the mold, which, in the present instance, consists of a flat annular horizontal base 25 and annular vertically extending inner and outer sides 26 and 27, all of which are made of non-magnetic material, preferably brass.

Any suitable means for rotating the shaft 11 may be provided, a pulley 28 thereon, for the purpose, being shown, and to provide means for energizing the electromagnet as herein described, one of the coil terminals is grounded on the frame and the other is connected to a contact ring 29 on the shaft, a contact device being arranged to engage said ring and suitable conne-
tions being made with a direct current genera-
tor.

The abrasive grains, when prepared for intro-
duction into the mold as already described, are
coated with a suitable bond, and must be in a
freely granular state, as stated before, so that
they may be fed practically separately, or in a
shower to the mold and any suitable means
which will accomplish this result is within the
scope of my invention. This may be done by
having any convenient manner, or automatically,
as by the means indicated on the drawings.
The means indicated comprises an endless belt
which passes down about a pulley 31, and to
which the prepared grains of material are gra-
dually fed, the pulley 31 being located over and
in radial relation to the annular mold, so that
the abrasive grains will be delivered in a thin
shower to the mold transversely thereof, or rad-
ially of its axis. The mold will be slowly rotated,
so that the grains will be evenly distributed
therein, the belt being slightly inclined from its
inner edge to its outer edge, so that the quantity
fed will gradually increase from the inner to
the outer periphery.

The operation with the above described appa-
ratous is as follows: The electro-magnet will be
energized and the shaft 13 will be rotated slowly
so as to produce a slight jarring action
on the mold and on the grains which are fed
thereto. As soon as the grains are delivered into
the magnetic field, the magnetic material, with
which they are coated, will become polarized, so
that, in the case of the grains which are substan-
tially longer than wide, their ends will normally
have opposite polarities and consequently there
will be a strong tendency to turn the positively
magnetically charged toward the negative magnet
pole and vice versa. The magnetic effect is
however not made sufficiently strong to move
the grains bodily towards either magnet pole,
but only to turn them in the direction of the
magnetic flux.

In the case of grains which are more nearly
equidimensional, but not actually spherical, but
which have various sharp pointed portions or
edges, the same polarizing effect will take place
as with the distinctly elongated grains, but there
will not be the same certainty as to the points
which will be polarized. There will, however, be
a strong tendency to form one of the poles at
the end of the main pointed portion of any par-
ticular grain of this form and consequently
there will be a tendency to turn this end towards
the magnet pole of opposite polarity, so that if
the grain has a sharp end portion or edge the
electrical attraction will tend to turn the grain
so that the end or edge will point toward one
pole or the other and if the grain has oppositely
located pointed end or edge portions, one of the
portions will ordinarily be pointed towards the
working face to be formed on the tool.

The apparatus Fig. 1 as the lines of force extent radially, the tendency will therefore be
to cause the elongated grains to lie in a radial
position and the other grains to have one of
their pointed portions pointed in a radial direc-
ton or towards one side of the mold. The turn-
ing or positioning action on the grains is likely
to occur to some extend while they are falling
into the mold, as they will become polarized as
soon as they pass into the electrical field, at
which time friction will not have to be overcome
in causing the grains to be positioned. The force
required to turn the grains when resting on the
bottom of the mold is also slight, but, after the
bottom has been covered with the grains, there
is a tendency for the grains to lodge in posi-
tions other than that desired. The tapping, jar-
ring, or vibratory action on the grains caused by
the pneumatic hammer acts to dislodge them
sufficiently, in most instances, to permit the mag-
etic forces to operate, or automatically, so that their pointed portions will be pointed in
the direction of the lines of force, as above
described. This simultaneous action of the elec-
tro-magnetic force and vibration, goes on con-
stantly as the mold is filled, so that the abrasive
grains will mainly be turned into positions in which one of the ends or pointed portions there-
of will point towards the outer side of the mold,
the inner surface of which corresponds to the
abrasive face of the tool, or other device when
finished. This condition is maintained through-
out both the thickness of the mold and radially of
the tool, as indicated in Figs. 3 and 4.

After the mold has been filled and the grains
have been mainly turned to positions in which
they point towards, or are approximately perpen-
dicular to the axis of the mold, as formed, the
usual steps of compressing the grains in the
mold and then firing will be performed.

The formation of certain other types of abra-
sive tools by the above described method re-
quires certain modifications of the apparatus
above described. The basic principle is the same,
but the mold is placed in a holder in which the abrading face is to be at the
end, or of a wheel in which the abrading face
is to be at either side, an apparatus similar to
that illustrated in Figs. 5 and 6 is preferably
employed.

In this construction a base 40 is provided, which is mounted on the upper end of a shaft
11a, similarly supported and driven to the shaft
11 before described, and has a mold supported
thereon which comprises a horizontal bottom 42
and vertical annular concentrically arranged
sides 43 and 44, the space between which cor-
responds to the shape of tool to be formed, and
these parts being formed of non magnetic mat-
erial, as brass. A series of electromagnets 45 are
mounted on a fixed support, not shown, in radial
relation to the mold. The construction of a cylin-
der in which the abrading face is to be at the
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end, or of a wheel in which the abrading face
is to be at either side, an apparatus similar to
that illustrated in Figs. 5 and 6 is preferably
employed.
tically all of the grains which have unequal dimensions will be polarized and turned so that one of their ends is in the general direction of the flow of the magnetic flux. Also, that while the jolting action may be somewhat effective in causing the grains to be packed more closely together, it is practically ineffective without the use of the magnetic flux, in causing the grains to adopt certain directions in accordance with the direction of the flow of the magnetic flux.

In forming an oblong abrasive block, in which it is desired that certain opposite sides be employed as the abrading faces, similar apparatus will be employed. In the construction shown in Figs. 7 and 8 a mold of rectangular form is illustrated, having a bottom 50 and upright sides and ends 51 of nonmagnetic material, said mold being mounted on a support 52, so arranged that it may be struck by the hammer 15 to cause suitable agitation of the grains therein.

A series of electromagnets 56 are fixed at each side of the mold, said magnets having their poles of corresponding polarity connected to armatures 57 and 58 disposed at opposite sides of the mold 50.

While an automatic feeding and distributing mechanism may be employed in this connection, hand feeding may be satisfactorily employed, so that no feeding means is illustrated. With this construction the magnetic flux will pass horizontally through the mold from one side to the other, causing a polarizing effect on all of the grains of abrasive as they fall therein and tending to move those which are elongated into positions perpendicular to said sides, or those which have definite pointed portions, into positions in which such portions point towards one or the other of said sides adjacent which the magnet poles are located.

A form of article produced by the above described methods is indicated in Fig. 9, but it will be understood that the form of article in which my invention may be embodied may be varied indefinitely, and that similar methods may be employed in coating flexible sheets with abrasive material.

It will be understood that my invention is not limited to an abrasive tool in which the abrasive grains point towards the abrasive face in an exactly perpendicular, or radial direction, as equally advantageous, or possibly even more advantageous results may be secured if the grains point towards the face at a slight inclination, so that it will be understood that any approximation of the direction in which the grains point to a perpendicular, or radial relation to the face, which is found to be advantageous, is within the spirit and scope of my invention.

An abrasive device or tool constructed as above described has substantially greater efficiency than a corresponding article in which the abrasive grains lie mainly sidewise, or nearly so, to the abrasive face, as it will be more free-cutting and less likely to heat the work. Also the wearing qualities will be greater for this and other reasons. The advantages thus secured are believed to far more than offset the slight increase of cost of manufacture in comparison.

I claim:

1. The method of forming an abrading device having an abrading face from granular abrasive material composed of grains each having a pointed projecting portion, which consists in delivering the material to a mold and simultaneously magnetically positioning said grains, as they are delivered, by lines of force directed in angular relation to the abrading face to be formed, to cause the projecting portions to be mainly pointed towards said face and then bonding the grains as positioned.

2. The method of making an abrading tool having an abrading face, which consists in showing granular abrasive material, composed of grains each having a pointed projecting portion, into a forming device, polarizing the grains as they are delivered to said device by lines of force directed to turn the grains to positions in which a projecting portion will be pointed towards the face to be formed, and then bonding the grains as positioned.

3. The method of making an abrading device having an abrading face, which consists in delivering granular abrasive material containing a substantial proportion of elongated grains, to a forming means corresponding to the device to be produced, polarizing said elongated grains as delivered by suitably magnetized poles so that they will be positioned in corresponding angular relation to the abrading face to be formed, and thereafter bonding the grains as positioned.

4. The method of making an abrading device from granular abrasive material containing grains each having a pointed projecting portion, which consists in showing the material into a mold corresponding to the device to be formed, polarizing said grains while being delivered and after delivering to said mold by electrical lines of force directed in angular relation to the abrading face to be formed, so to position said grains that their said projecting portions will mainly point correspondingly, and thereafter bonding said grains as positioned.

5. The method of making an abrading device, which consists in showing granular abrasive material containing a substantial proportion of elongated grains into an open mold one side of which corresponds to the abrading face to be formed on said device, position the elongated grains in corresponding angular relation to the face-forming side of the mold by polarizing said grains as delivered thereto by a suitably located electrical flux, and thereafter bonding the grains as positioned.

6. The method of making an abrading device from granular abrasive material containing grains each having a pointed projecting portion, which consists in coating the grains with magnetic material, showing the magnetically coated grains into a forming means and between magnet poles arranged to cause a magnetic flux at an angle to the abrading face to be formed on said device, to position the grains, so that their projecting portions point mainly in the direction of the flux, and thereafter bonding the grains as positioned.

7. The method of making an abrading device from granular abrasive material composed of grains each having a pointed projecting portion, which consists in coating the grains with a sufficient quantity of a magnetic substance to render the grains susceptible to magnetic influence, showing the grains into a mold corresponding to the device to be formed through a magnetic field, the lines of force of which extend in angular relation to the abrading face to be formed on said device, so to position the grains that their said projection portions will mainly point towards the abrading face to be formed on said device, and then bonding the grains as positioned.

8. The method of making an abrading device...
from granular abrasive material containing a substantial proportion of elongated grains, which consists in coating the grains with a sufficient quantity of a magnetic substance to render the grains susceptible to magnetic influence, providing a mold corresponding to the shape of the device to be formed and arranging the poles of an electromagnet in opposite relation to the sides of the mold which correspond to the abrasive face to be formed, showering the material into the mold while the poles are energized to cause the elongated grains to be magnetically positioned in the direction of the flux between the poles and thereafter bonding the grains as positioned.

The method of forming an abrading device from unequidimensional abrasive grains, which consists in magnetically positioning said grains correspondingly with relation to the abrasive face to be formed and bonding them as positioned.

The method of forming an abrading device from unequidimensional, non-magnetic abrasive grains, which consists in providing said grains with a ferrous coating, positioning said grains correspondingly with relation to the abrading face to be formed, by subjecting them to the influence of a magnetic flux and then bonding them as positioned.

An apparatus for producing inflexible abrasive tools comprising a mold corresponding to the shape of the tool to be formed, and a magnet having its poles disposed to produce lines of force within the mold which are directed approximately perpendicularly to a face—forming side of the mold.

An apparatus for producing inflexible abrasive tools comprising a mold corresponding to the shape of the tool to be formed, and a magnet having its poles disposed to produce lines of force within the mold which are directed approximately perpendicularly to a face—forming side of the mold.