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3,406,489

ABRADING WHEEL STRUCTURE

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2 Sheets-Sheet 1

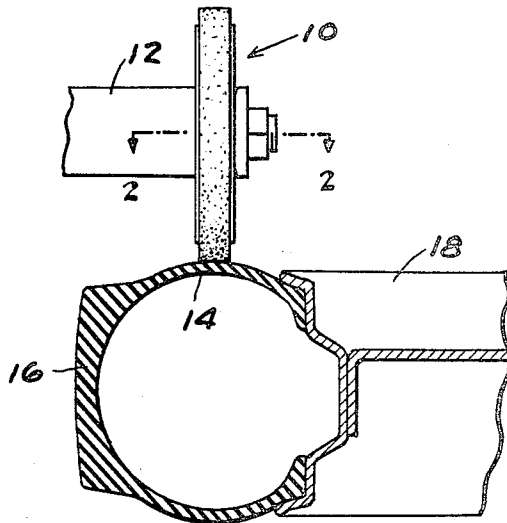


FIG. 1

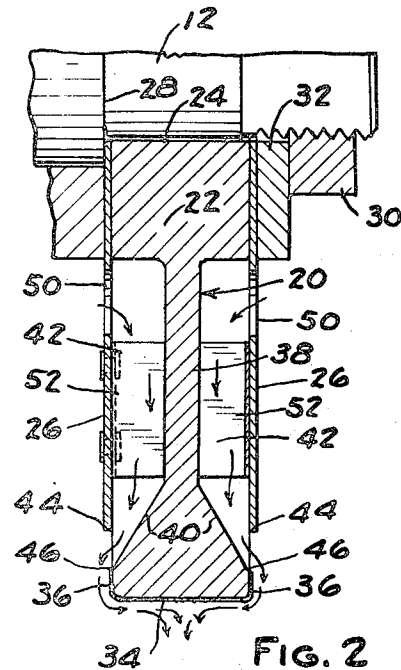


FIG. 2

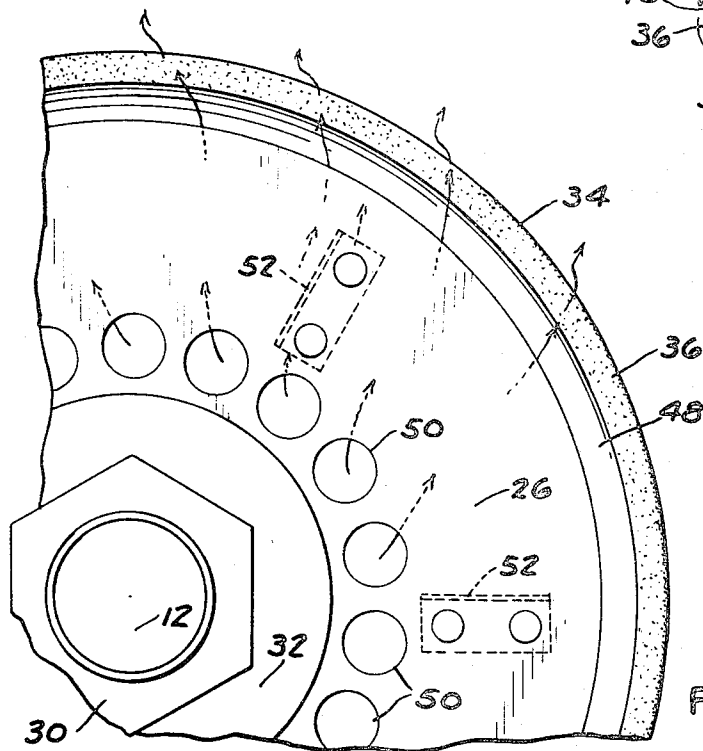


FIG. 3

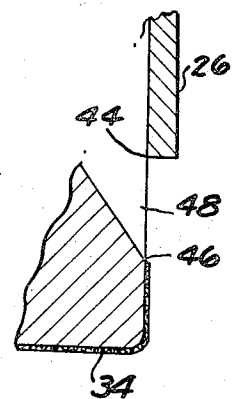


FIG. 2A

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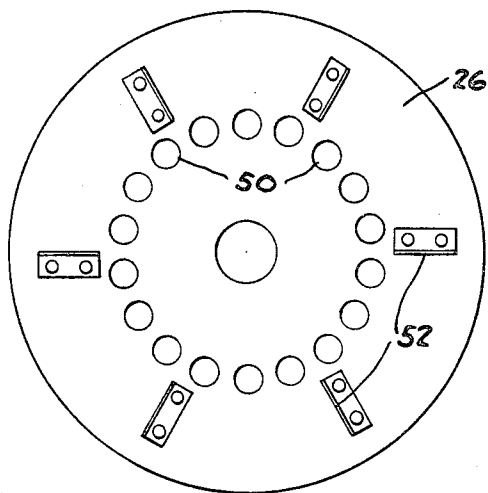


FIG. 4

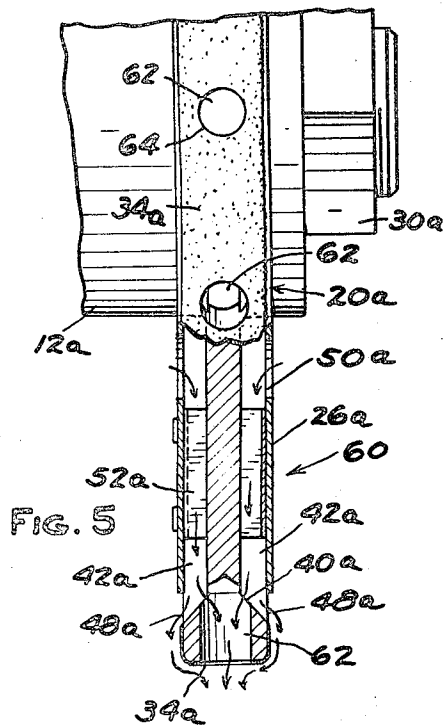


FIG. 5

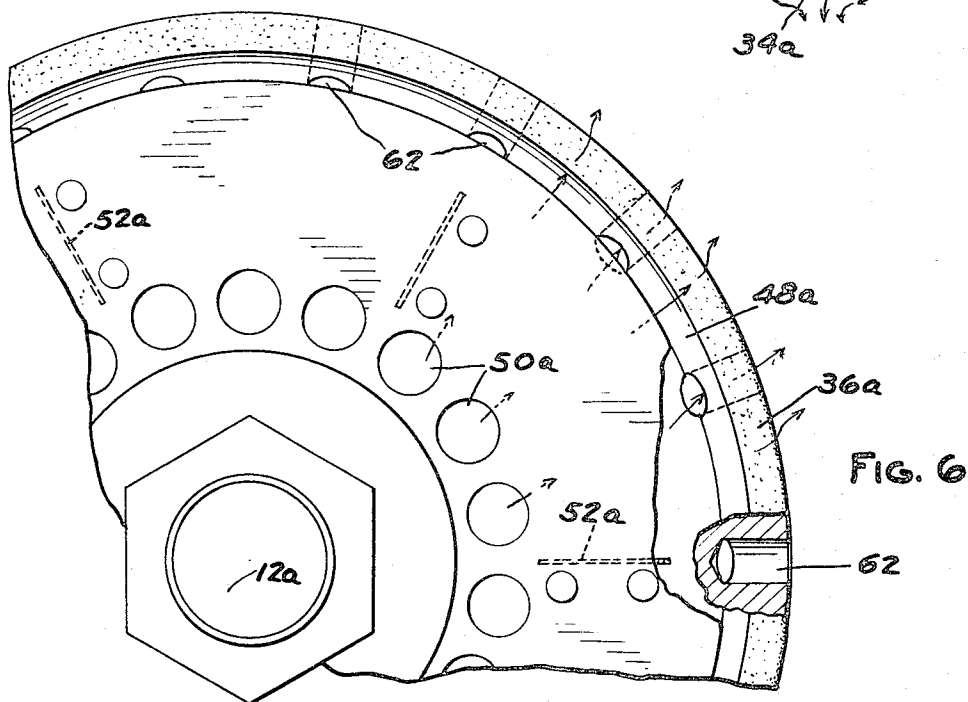


FIG. 6

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ABRADING WHEEL STRUCTURE

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18 Claims. (Cl. 51—356)

This invention relates to an abrading wheel for grinding or abrading work pieces made of different kinds of materials which may range from relatively hard steel and other metals to relatively soft gummy rubber.

A condition common to all grinding operations is that heat is generated at the surface being ground or abraded. In some situations, unless cooling means are provided, the heat can damage the work or heat the rotating wheel to a point where it may disintegrate under centrifugal force. Moreover, where flammable dust results from the grinding, the frictional heat at the wheel may ignite the dust and cause an explosion. A further problem frequently present is how to remove the dust particles from the work; i.e. how to clean the work. Conventional abrading wheel structures and associated equipment have not satisfactorily dealt with these problems.

The object of this invention is to provide a relatively simple, inexpensive abrading wheel structure which is improved to keep both the wheel and the work relatively cool and to cause the dust particles formed during the abrading to be removed from the work as they are formed.

The invention is carried out generally by providing the wheel with a generally radially extending rim adjacent the outer peripheral abrasive surface. The side face of the wheel is provided with a radial passageway, the outlet of which is immediately adjacent the inner edge of the rim. Between the outlet and the passageway inlet, impeller vanes are provided to promote a radially outward flow of air when the wheel is rotated. Air issuing from the outlet follows the contour of the rim and is directed radially in a high velocity thin film or ribbon against the work immediately adjacent the side faces of the wheel. This air cools the work and the wheel and blows the dust or particles away from the work.

For reasons discussed below, the problems referred to above are particularly acute in the abrading of rubber as in the manufacture of automotive vehicle tires. This art is therefore selected for illustration of the invention.

In the drawings:

FIG. 1 is a partly diagrammatic view partly in section and partly in elevation of a wheel according to this invention in use.

FIG. 2 is a fragmentary partly diagrammatic sectional view on line 2—2 of FIG. 1 on an enlarged scale.

FIG. 2a is an enlarged fragmentary diagrammatic view illustrating the relation between structural features shown in FIG. 2.

FIG. 3 is a fragmentary elevational view of the wheel shown in FIG. 1 on an enlarged scale.

FIG. 4 is an elevational view of a plate used in conjunction with the wheel body.

FIG. 5 is a view similar to FIG. 2 but showing a modified form of the invention.

FIG. 6 is a view similar to FIG. 3 but illustrating the modified form of the invention.

Shown in the drawings is an abrading wheel 10 according to this invention mounted on a rotating shaft 12 and being used to grind a groove in a portion of a sidewall 14 of a tire 16. As is conventional in tire manufacture, the tire is mounted on a rim 18 and inflated. The rim is rotated about an axis which is vertical as the drawings are viewed to carry successive circumferential portions of sidewall 14 into contact with wheel 10.

Wheel 10 has a body 20 with a central hub 22 apertured

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at 24 to fit around a portion of shaft 12 (FIG. 2). A pair of plates 26 are mounted over opposite side faces of the wheel body and for this purpose the plates and hub 22 may be clamped against a shoulder 28 on shaft 12 by means of a nut 30 threaded on to the shaft and an interposed clamping washer 32.

Wheel body 20 has an outer peripheral abrasive surface 34 by which the work is abraded or ground. Depending upon the material of the work piece and the nature of the work to be performed, wheel body 20 may be made of a conventional abrading material such as silicon carbide or aluminum oxide or the wheel may comprise a metal substrate whose periphery is coated with a layer of abrasive particles such as tungsten carbide to provide abrading surface 34. The latter type of wheel body is illustrated. The abrasive grits may be applied to the substrate metal by the method disclosed in Harris 3,248,189.

Immediately adjacent its outer peripheral surface, wheel body 20 is provided with rim portions 36 which extend in a generally radial direction. The side faces of wheel 20 are axially dished or recessed between hub 22 and rim 36. The recessing illustrated results in a central web 38 and radially and axially outwardly tapering portions 40 between web and rims 36.

Plates 26 project radially over the recessing in the wheel body and thereby form radial passageways 42. Each plate 26 has an outer peripheral edge 44 spaced radially inwardly of the inner edge 46 of rim 36. This spacing defines a circumferential slot 48 extending around each side of wheel 10 and forming the outlets of passageways 42. The inlets for passageway 42 are disposed radially inwardly of the outlets and conveniently comprise a circumferential series of ports 50 in plates 26. The portion of plate 26 which defines the inner side of opening 48 is preferably no further in an axial direction from the radial center of the wheel than is inner edge 46 of rim 36. This is illustrated in FIG. 2a wherein the axially inner corner of the periphery of plate 26 defines the inner side of slot 48 and is substantially radially aligned with inner rim edge 46.

Impeller blades or vanes 52 are mounted within passageway 42 so that as wheel 10 is rotated, they promote a flow of air from inlets 50 radially outwardly to outlets 48. For convenience of manufacture, these vanes are shown as being secured to the inner faces of plates 26 as by riveting.

In use it may be assumed that wheel 10 is mounted on shaft 12 by the means described and that the wheel is being rotated in abrading engagement against rotating tire wall 14. As the wheel rotates, air is drawn into passageway 42 through inlet ports 50 and is forced centrifugally radially outwardly toward outlet slots 48. Vanes 52 promote this outward flow of air. Even though slots 48 are disposed in a direction axially outward of the wheel, when the air issues through the slots, it does not flow axially away from the sides of wheel 10. To the contrary, the air concentrates in a very thin ribbon or film which closely hugs rims 36 and is directed in a radial direction against the work in a thin high velocity stream. This flow of air is so concentrated and is of such high velocity that it effectively cools both the wheel and the work and blows the dust or particles caused by the abrading completely away from the work area and thereby cleans the work.

It is not thoroughly understood why the air issuing from outlet slots 48 closely follows the external surface of the wheel radially outwardly of plates 26. It is theorized that this phenomenon is a manifestation of the Coanda effect. Be this as it may, however, the air stream does behave in the manner described. In fact, tests have shown

that when the wheel is rotated out of engagement with the work, the air stream tends to turn axially inwardly around the outer edges of rims 36 and to follow the contour of abrasive surface 34 as represented by the arrows in FIG. 2.

By way of further illustration, when an axially relatively narrow wheel 10 is used, e.g., up to about .80 inch, the air stream has relatively small volume because passageways 42 are shallow and substantially the entire air stream is injected into the cracks between rims 36 and the sides of the groove formed in the tire. This is manifested by the fact that the dust, though entirely cleaned out of the groove, is deposited in small circumferential mounds adjacent the sides of the groove. This dust is easily brushed off of the tire. When wider wheels 10 are used having deeper passageways 42, a greater volume of air issues from slots 48 and some of the air is diverted outwardly away from the groove, blowing all of the dust away from the tire.

It has been found that the described behavior of the air stream obtains when edges 44 defining the inner sides of openings 48 are disposed either in the same radial plane as inner edges 46 of rims 36 or axially inwardly thereof. If inner edges 44 are disposed axially outwardly of rim edges 46 to an appreciable extent, the air stream issuing from openings 48 tends to dissipate axially away from the wheel rather than hugging rims 36. For a typical wheel 10 the air stream is most effective when the radial distance from plate edge 44 to rim edge 46 is of the order of about 1/8 inch to about 1/4 inch.

For a typical wheel 10 the most effective air flow occurs when the total area of a slot 48 is in the range from about 15 percent to about 35 percent of the total area of the inlet ports 50 serving the slot. When this percentage is increased to about 60 percent the described phenomenon still exists although the velocity of the air stream issuing from the slot is considerably less. When this percentage is further increased turbulence occurs and the system becomes ineffective.

Rims 36 need not extend precisely in planes radial of the wheel. They could be sloped somewhat outwardly or inwardly and could have a rounded contour. In any such case, the rim portions would extend in a generally radial direction as contemplated herein.

In actual tire manufacture, a typical wheel 10 according to this invention has a diameter of 8 inches and is rotated at about 7,000 r.p.m. in grinding engagement with tire wall 14. In a 12 second cycle, the wheel cuts a groove throughout the circumference of the sidewall, the groove being 1 1/8 inches wide by about .050 inch deep. The tire is a typical 8 x 14 automobile tire. A single wheel 10 has been capable of so abrading up to 300,000 tires without failure or the necessity of replacement.

Using conventional equipment, elaborate systems of air jets have been used to cool the work area. Even with such equipment, cooling has been unsatisfactory to the extent that the dust particles formed melt and fuse in agglomerations to the sidewall. Secondly, the heat generated is sufficient to create the continual hazard of ignition and explosion of the flammable rubber dust particles. Thirdly, the tire, after the grinding operation, must be subjected to a separate cleaning step to remove the dust and agglomerations formed during the grinding.

Use of wheel 10 so cools the wheel and the work that the agglomerations and the danger of explosions are eliminated. Moreover, the work area of the tire is thoroughly cleaned by the air blast from openings 48, thereby eliminating the necessity of a separate cleaning step in tire manufacture. The external system of cooling jets is eliminated.

The emphasis laid herein upon use of wheel 10 in tire manufacture is merely to illustrate the effectiveness of the wheel under very exacting conditions wherein a great deal of frictional heat is generated, unusual quantities of flammable dust are created, the work piece and wheel

would be damageable by the frictional heat without adequate cooling, and the work piece must emerge from the grinding equipment in clean condition. Wheel 10, however, obviously is not limited to the grinding of rubber.

The wheel is useful in grinding or abrading a wide range of materials from relatively soft rubber through relatively hard steel.

FIGS. 5 and 6 illustrate a modified form of wheel 60 generally similar to wheel 10 except that a circumferential series of radial ports 62 are provided in the rim portions of wheel body 20a. These ports open outwardly through abrasive surface 34a and penetrate inwardly through sloped portions 40a so that they are in air-flow communication with passageways 42a. In general, the structural features of wheel 60 bear the same reference characters as the corresponding features of wheel 10 with the addition of the letter "a."

This form of wheel functions similar to wheel 10 except that in addition, air flows radially outwardly through ports 62 against the work. In addition, where ports 62 interrupt surface 34a irregularities 64 are formed which assist in the abrading or cutting of the work piece. This form of wheel has been found particularly useful in the abrading of relatively soft gummy rubber and the like.

I claim:

1. Abrading wheel structure which comprises:
 - a wheel having a central portion adapted to be mounted on a shaft and having a peripheral abrasive surface, said wheel having a rim portion adjacent said surface which extends in a generally radial direction,
 - means defining a passageway having an axially disposed outlet adjacent the inner radial edge of said rim portion and having an inlet radially inward of said outlet,
 - and vane means effective to promote radially outward movement of air in said passageway responsive to rotation of said wheel.
2. The wheel structure defined in claim 1 wherein said means defining said passageway comprises axial recessing in said wheel and cover means over said recessing.
3. The wheel structure defined in claim 2 wherein said cover means has a radially outer edge portion spaced radially inwardly of said rim portion and defining a side of said outlet.
4. The wheel structure defined in claim 2 wherein said vane means is carried by said cover means.
5. The wheel structure defined in claim 3 wherein said wheel has a face portion which is axially dished to provide said recessing, said cover means comprises a plate mounted over said recessing, said outer edge portion of said plate cooperating with the inner edge of said rim portion to form an annular slot which provides said outlet.
6. The wheel structure defined in claim 5 wherein said plate has a central portion mounted on the central portion of the wheel, said plate being provided with porting which comprises said inlet.
7. The wheel structure defined in claim 6 wherein said porting comprises an annular series of ports outwardly of said central portion of said plate.
8. The wheel structure defined in claim 3 wherein the radially inner edge of said rim portion defines a side of said outlet, said edge portion of said cover means being disposed substantially no further axially from the central radial plane of the wheel than said inner edge of said rim portion.
9. The wheel structure defined in claim 8 wherein said outer edge portion of said plate and said inner edge of said rim portion are disposed in substantially the same radial plane.
10. The wheel structure defined in claim 1 wherein said wheel has a portion contiguous with said rim portion which slopes toward the axial and radial centers of the wheel and which underlies said outlet.
11. The wheel structure defined in claim 1 wherein the

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side faces of said wheel are dished to provide annular recessing on each side of the wheel between said central portion and rim portion, said wheel having a portion which tapers between said rim portion and the bottom of said recessing, an annular cover plate secured over the dished portion of each side of said wheel, said dished portion and said cover plate cooperating to define said passageway, said cover plate having a radially outer edge spaced radially inwardly of the radial inward edge of said rim portion so that said edges of said cover plate and rim portion cooperate to define an annular slot which forms said outlet, said edge of said plate being disposed substantially no further axially from the central radial plane of the wheel than said inner edge of said rim portion.

12. The wheel structure defined in claim 1 wherein said abrasive surface is substantially imperforate.

13. The wheel structure defined in claim 1 wherein said wheel is provided with porting which opens substantially radially through said peripheral surface, said porting being in air-flow communication with said passageway.

14. The wheel structure defined in claim 11 wherein said wheel is provided with a circumferential series of

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ports, each of which opens radially outwardly through said peripheral surface and opens inwardly through said taper portions of said wheel whereby to pass air from said passageway to said peripheral surface.

15. The wheel structure defined in claim 1 wherein the area of said outlet is in the range from about 15 percent to a maximum of between about 35 percent and about 60 percent of the area of said inlet.

16. The wheel structure defined in claim 15 wherein said maximum is about 35 percent.

17. The wheel structure defined in claim 15 wherein said maximum is about 60 percent.

18. The wheel structure defined in claim 1 wherein said outlet has a radial extent in the range from about one-eighth inch to about one-quarter inch.

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OTHELL M. SIMPSON, *Primary Examiner*.