April 9, 1946.

R. W. HACKETT

2,398,224

ABRASIVE DISK

Filed Oct. 8, 1941

Fig. 1

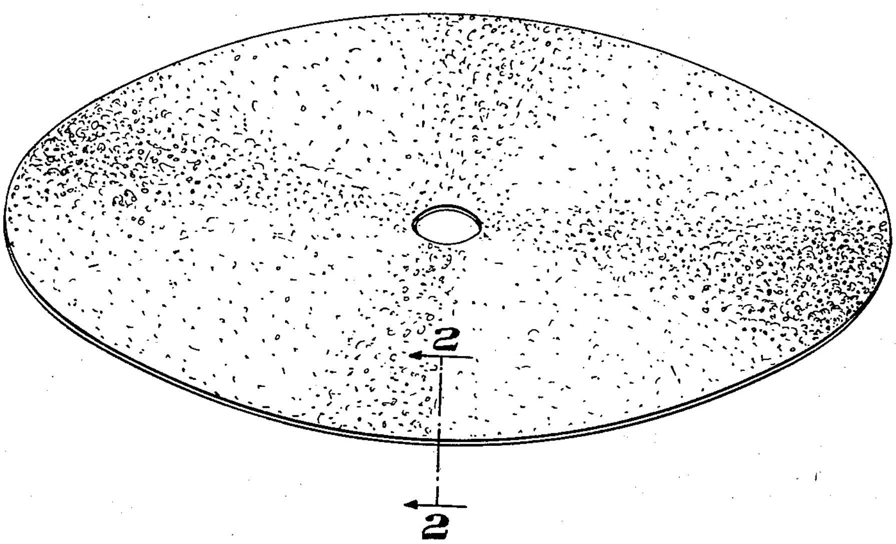
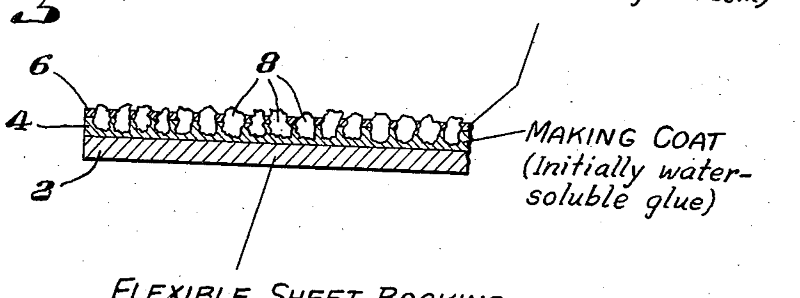


Fig. 2



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ABRASIVE DISK

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6 Claims. (Cl. 51—301)

This invention relates to abrasive sheet material and more particularly to flexible abrading disks of the type extensively used in grinding operations on metal.

Animal glue adhesives, which are widely used in making abrasive sheet products as a means for attaching the abrasive grit, are subject to certain drawbacks when used in the manufacture of abrasive metal grinding disks, especially those having fairly stiff sheet backing material for use in so-called "heavy duty" work.

In the first place, these disks are rotated at very high speeds, which develop high surface temperatures at the point of abrasion. These temperatures naturally have a pronounced effect on the material which bonds the abrasive grit to the backing. When such disks are surfaced with conventional animal glue adhesive coats, the glue, being thermoplastic and having little or no heat resistance, tends to soften and become tacky after short abrading use at high rotating speeds. The softened adhesive then attracts and holds dust which arises from the abrading operation. Accumulation of such dust on grinding wheel disks is a very real problem, as such accumulation progressively diminishes the cutting power of the abrasive grit and the life of the disk is measurably shortened despite the fact that the grit remains potentially abradant and is still satisfactorily bonded to the sheet backing. The life of the disk then ceases to be measured by the integrity of the elements, but is rather measured by the rate of accumulation of dust between the grit and resulting loss of free cutting action.

For the above reason, such glue surfaced disks are not inherently adapted for efficient use in operations developing high friction heat.

A second objection to the use of such glue in abrasive disks, especially where relatively stiff, tough, backings are used, is that the glue, the term glue being herein used to mean animal glue, in its ordinary form, is hygroscopic and subject to change in atmospheric conditions. When used as a binder for grit, therefore, in metal grinding flexible disks of relatively small diameter, the manufacturer is confronted with a curling tendency resulting from the effects of change in the amount of moisture present in the surrounding atmosphere. In many instances this curling tendency necessitates a special steaming operation after drying of the completed sheet and even then, subsequent conditions of storage may later cause such curling of the disk as to ruin it because it cannot be suitably flattened in attaching it to the grinding machine.

Because of the drawbacks of glue a few manufacturers have resorted to substitute adhesives and such a substitute adhesive for binding the abrasive grit has been suggested in U. S. patent to Redman No. 2,176,942. This particular patent describes the use of a heat hardened resin binding coat allegedly flexibilized by certain modifying agents, for attaching the grit to the backing. But disks, especially those manufactured for use in metal grinding operations, in which the abrasive is bonded to the backing by such substitute adhesives are much inferior from the standpoint of cutting power. Unlike glue, resinous materials have a pronounced tendency to coat over and varnish the abrasive grit. This is due to the fact that coatings of such resinous materials do not set quickly. After abrasive grains have therefore been sprinkled on a coating of the liquid syrupy resinous material they have a tendency to bury themselves by sinking down into the coating before it sets. This results in the resinous material coating over the tops of many of the smaller particles and often of all the grit where festooning is utilized during drying. Where the grit is buried, substantial loss of free cutting power results. Glue, on the other hand, is customarily applied hot to the backing and skims over to an appreciable extent even before the abrasive grit can be spread and sets long before the weight of the grit can function to sink the grit into the glue. In other words the longer a binder remains wet and unset after application of a grit, the more liable is the grit to become buried. Glue has always been considered the most satisfactory abrasive binder because of its characteristics which insure that the grit when spread will not become embedded in the glue coating and that the ends of the particles will be exposed and uncovered, thereby providing a powerful cutting surface.

Additionally, resinous binding coats are inferior to glue in qualities of strength, resilience, flexibility and toughness, especially when they do not include plasticizing agents and catalysts which, if used, complicate their formulation.

For the above reasons, retention of a glue making or bonding coating is, in the last analysis, highly desirable in the manufacture of these disks, especially when one considers that the simplicity and cheapness of a glue bond are universally recognized as unsurpassed. Nevertheless, unless dust accumulation be overcome, its advantages are, for practical purposes, nullified so far as prolonging the useful life of the disk is concerned.

Accordingly, it is an object of this invention to overcome the dust accumulation difficulty arising in abrasive disks having glue adhesive bonding agents, and it is additionally an object to overcome simultaneously the curling defect heretofore encountered in glue bonded abrasive disks. Stated positively my invention seeks a more stable glue bond and one which is not so noticeably subject to changes in atmospheric humidity conditions.

When a glue bonded abrasive disk is supplied with an overlying protective coat on the abrasive surface which is not subject to softening as a result of the operating heat, the clogging difficulty may be overcome. Heretofore infusible resins have been discarded by those skilled in the art as having a practical use in such overlying coats because, by their very nature, they involve heat treatment to harden and render them dry, and glue cannot be subjected to the temperatures necessary to perform this operation without invariably making the glue brittle after cooling, impairing its toughness and strength, and destroying the very qualities which are responsible for its choice. Experienced abrasive manufacturers accept the principle that heat treatment of set glue during manufacture will destroy its superiority as a binder and render it commercially unacceptable because of its tendency to crack and break up.

I have found, however, that if a heat-hardenable water-soluble phenol-aldehyde resin is spread in aqueous solution over a glue making coat, the composite material may be baked at the necessary temperature to harden the resinous top coat without rendering the glue coat brittle after cooling, and, in fact with noticeable improvement in the strength and toughness of the glue making coat.

This phenomenon is responsible for my ability to make a vastly improved glue bonded abrading disk, the life of which is measurably lengthened due to the combined presence of a highly adhesive tough and flexible glue making coat plus a heat hardened hard, dry, heat resistant top surface coat, but with the glue in no worse condition for adhesive purposes than if it had not been subjected to heat.

My explanation for this phenomenom is that by applying the resin in a solvent which is a mutual solvent for glue, i. e., water, and by using a phenol-aldehyde resin, the resin is to some degree carried into and penetrates the glue coat and, because of the inherent characteristics of the resin, the glue coat, is, in a sense, conditioned by the resinous ingredients so that it survives the heat treatment involved in the subsequent baking without developing brittleness.

In accordance with this explanation, and as I have found in practice, it is only the aqueous spread water-soluble, phenolic condensation resins which have this heat protective brittleness-preventing capacity when applied over a glue coat.

Secondly, I have discovered that certain water-soluble phenol-aldehyde resins not only act to condition the glue for surviving the heat treatment, but in addition render the glue less hygroscopic and consequently less subject to curling after drying. The phenol-formaldehyde resins are especially effective for this purpose, and I attribute this action to the free formaldehyde content which is present in water-soluble phenol-formaldehyde resins. Because of the aqueous spreading, the resin penetrates into the aqueous wettable glue, carrying with it the free formaldehyde content which, in accordance with known principles, cures and conditions glue to render it moisture resistant. While the phenol-formaldehyde resins are especially efficacious, any of the phenol-aldehyde resins which have a free formaldehyde content running from approximately 3% to 5% would be suitable to accomplish this object.

To describe more fully an embodiment of my invention, a conventional fiberboard or combination paper and cloth flexible backing otherwise suitable for the purpose may be coated with a making coat of a hot conventional glue adhesive. Abrasive grains are then spread over the glue as it sets, and before complete drying of the glue, an aqueous solution of a water-soluble phenol-formaldehyde resin is spread, as by a doctor blade or roll, over the abrasive coated surface. Because the glue has partially set, it takes up the aqueous applied solution, with the result that the resin penetrates into the glue coating and tends to prevent varnishing over or burying of the grit, especially if the precaution of squeezing off excess solution is taken, as by passing the material through pressure squeeze rolls. After application of the top coating, the composite material is allowed to dry. Thereafter the sheet material may be baked and subsequently cut into disk shape.

Such a disk is illustrated in the accompanying drawing in which

Fig. 1 is a perspective view of an abrasive disk and

Fig. 2 is a diagrammatic cross-sectional view taken along the line 2—2 of Fig. 1.

As shown in Fig. 2 the disk comprises a flexible sheet backing 2 bearing a making coat of glue 4 bonding abrasive grit 8 to the backing 2 and a protective coat 6 of the heat-hardened but initially water-soluble phenolic resin, the whole sheet having been baked to harden the coat 8.

While the temperature and time of baking will vary depending upon particular conditions of grit size, coating thickness and other factors with which those in the art are familiar, as well as upon the particular type of water-soluble phenolic resin being used, in practice I have found that, when using the water-soluble phenolic resin now available on the market as a product of Catalin Corporation under the tradename "Catabond No. 630," a temperature of the range of 200° F. overnight is suitable. While I mention this particular phenolic resin, no doubt there are other water-soluble phenol-aldehyde condensation products having the same characteristics, elsewhere available, though this material seems especially suitable from the standpoint of its free formaldehyde content, which runs from approximately 3–5%. The temperatures necessary for securing a permanent set may vary with the use of other similar resins from room temperature upwardly to 250° F.

It is apparent that my invention is applicable to other types of flexible abrasive sheets, for instance all types of sandpapers and abrasive cloths, and is available for equally advantageous use wherever a baked back coating is desired as well as a baked working surface coat in connection with an abrasive sheet having a glue bonded grit.

In its preferred form, an abrasive disk manufactured in accordance with this invention presents a very powerful cutting surface which is stable and not affected by heat; its surface remains hard and non-sticky without tendency to fuse, even when operating against metal at speeds of 4500 linear feet per minute or higher, at which speeds temperatures of 750° F. to 1200° F. and over are often developed on the abrading surface. At the same time, the grit is bonded to the backing by a tough flexible and highly adherent and coherent glue having at least as good adhesive characteristics as normal glue despite exposure of the glue during manufacturing operations to temperatures which normally render glue adhesives undesirably brittle. Further, the glue coat is more moisture-resistant than normally and will survive atmospheric humidity changes without undue curling of the cut-out disk.

I claim:

1. A flexible abrasive sheet comprising a flexible backing, abrasive grit affixed to said backing by a flexible tough non-brittle making coat of glue, and a heat-hardened dry heat resistant continuous protective coat formed of the dried residuum of an aqueous solution of an initially water-soluble phenol-aldehyde condensation resin overlying said making coat, surrounding and partially embedding said abrasive grit, penetrating said making coat and serving to maintain the flexibility and toughness of said glue making coat despite application of heat to said sheet in hardening said resin coat, said sheet presenting a working surface of said grit and said resin coat, which surface tends to shed abrading dust even at the high temperatures encountered in abrading operations.

2. The method of maintaining flexibility and toughness in a conventional abrasive grit glue binder coat when submitted to a baking operation which comprises coating said binder with a water-soluble heat hardenable phenol-aldehyde resin in aqueous solution, drying said resinous coating, and baking said resin to harden said resin to a hard, dry, heat resistant state.

3. The method of making a flexible abrasive sheet adapted for use in abrading operations developing high temperatures at the working surface, comprising affixing abrasive grit to a suitable flexible sheet backing by a making coat of glue, applying in aqueous solution over said glue coat before the glue has completely set, a water-soluble phenol-aldehyde condensation resin while allowing penetration of said resin in said aqueous solvent into said glue making coat, and then subsequently baking said sheet to set up said resin into a heat hardened, dry, heat-resistant coat, whereby said sheet will present a working surface of abrasive grit surrounded by said resin coat, the penetration of said resin into said glue serving to maintain the flexibility and toughness of said glue making coat despite said baking operation.

4. A baked flexible abrasive sheet having abrasive grit bonded to a flexible sheet backing by a flexible tough making coat of glue and an overlying heat-hardened protective coat of an initially water-soluble phenol-aldehyde resin, which sheet in its preparation has utilized the method of claim 2 for maintaining the flexibility and toughness of the glue coat during the baking of the sheet to harden the resin.

5. A baked abrasive sheet having abrasive grit bonded to a flexible sheet backing by a flexible tough making coat of glue and an overlying heat-hardened protective coat of an initially water-soluble phenol-aldehyde resin, which sheet has been prepared by the method claimed in claim 3.

6. The method of making a flexible abrasive sheet which comprises affixing abrasive grit to a flexible sheet backing with a glue adhesive, applying on the grit bearing surface of said sheet an aqueous solution of a heat hardenable water-soluble phenol-aldehyde resin having a free formaldehyde content, while allowing penetration of said resin in said aqueous solvent into said glue adhesive and subsequently setting up said phenolic resin to an infusible state.

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