

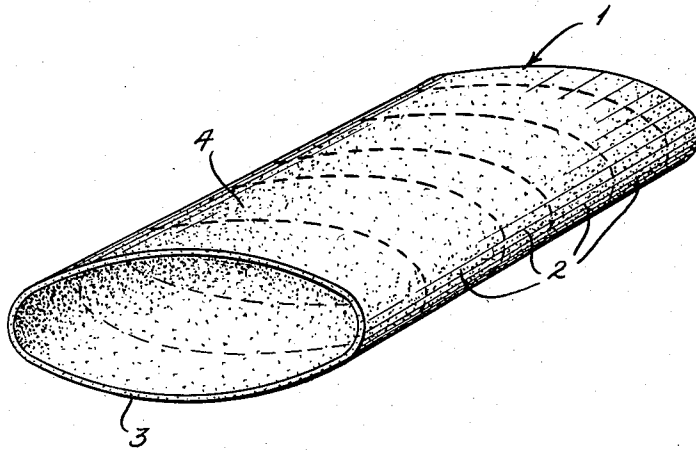
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POLISHING INSTRUMENT

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2,881,065

POLISHING INSTRUMENT

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This invention relates generally to the manufacture of articles having abrasive particles embedded therein and more particularly to an improved method for making solid polyurethane plastic polishing tools containing abrasive particles. Still more particularly, the invention relates to endless belts and the like having abrasive particles embedded therein and to a method for making such belts suitable for polishing various surfaces including, inter alia, glass and wood surfaces.

The heretofore available abrasive polishing belts are composed of an endless cloth belt having abrasive particles bound to the surface thereof. Such belts tear easily and wear excessively with the result that their service life is relatively short. Moreover, it is difficult to secure the abrasive particles to the cloth and the particles become detached rather easily as the belt is used. Another disadvantage of the cloth or other textile polishing belts is that the abrasive particles are only on the surface.

It is therefore an object of this invention to provide a process for making improved polishing tools. Still another object of the invention is to provide a process for making polishing tools having abrasive particles distributed homogeneously throughout the plastic article. A further object of the invention is to provide an improved process for making polyurethane articles having abrasive particles embedded therein which have outstanding polishing action on metal, glass and similar surfaces and permit grinding to close tolerances. A still further object is to provide a method for embedding particles of an abrasive in a polyurethane plastic having improved working characteristics and adaptability to producing articles of various shapes and dimensions. Another object is to provide grinding instruments which produce a microfinish on various types of tools and machine parts. A more specific object of the invention is to provide an endless abrasive polishing belt having an improved service life and a method for making such a belt.

In accordance with the processes described in my application Serial No. 625,624, filed December 3, 1956, and now abandoned, and my application Serial No. 635,597, filed January 23, 1957, and now abandoned, of which this application is a continuation, particles of an abrasive are dispersed in a more uniform distribution in a polyurethane plastic matrix. Those processes involve wetting or coating the surface of the abrasive particles with a dispersing agent such as, for example, a polyfunctional isocyanate or a suitable lubricant of the group represented by silicone oil, hydrocarbons, molybdenum sulfide and sulfur, prior to mixing the abrasive particles with the polyurethane plastic. Suitable hydrocarbons include graphite, paraffin wax, microcrystalline mineral wax and natural occurring waxes, such as ceresin and the like. It was found that a more homogeneous product in which the particles of abrasive are more tightly bound to the plastic are produced if the particles of abrasive are wet with such a dispersing agent and the resulting wet

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particles are then mixed with a castable polyurethane plastic. The abrasive articles may contain particles of any suitable abrasive material, such as, for example, Carborundum, boron carbide, silicon carbide, tungsten carbide, diamonds and the like.

It has now been found that an endless polishing belt having a much longer life than the heretofore available cloth belts may be made by dispersing particles of an abrasive in a polyurethane plastic mass and casting the mixture before it has hardened. The instant invention therefore provides a method for dispersing abrasive particles uniformly throughout a plastic mass and for forming the resulting dispersion into an endless belt. The belts are preferably formed by a centrifugal casting process but may also be formed by conventional molding procedures. It is preferred, in order to insure substantially uniform distribution of the abrasive particles in the finished belt, to wet the particles with a dispersing agent prior to mixing them with the castable polyurethane plastic melt. The dispersing agent may be an isocyanate or a lubricant of the type disclosed in my earlier applications.

Any suitable isocyanate may be utilized as the dispersing agent for treating the surface of the abrasive particles before they are mixed with the polyurethane plastic, but the isocyanate must have a reactivity with a compound having a reactive hydrogen atom that is at least as reactive as triphenylmethyl triisocyanate or p, p'-diphenylmethyl diisocyanate with such a compound. Triphenylmethyl triisocyanate has been found particularly advantageous and is preferred. Examples of other suitable isocyanates include p, p'-diphenylmethyl diisocyanate and any other aromatic polyisocyanate having a reactivity equivalent to or better than the reactivity of triphenylmethyl triisocyanate or p, p'-diphenylmethyl diisocyanate. Triisocyanates and diisocyanates of the required degree of reactivity are preferred.

Any suitable lubricant of the group represented by silicone oil, hydrocarbons, molybdenum sulfide and sulfur as well as a polyisocyanate may be utilized as the dispersing agent. Examples of suitable hydrocarbons are graphite, paraffin wax, microcrystalline mineral wax, natural occurring waxes such as ceresin and the like. The ratio of lubricant to abrasive particles must preferably be about 1 part by weight abrasive particles to about 12 parts by weight lubricant. Thus, it is possible either to wet or coat the particles with a polyisocyanate or with one of the aforementioned lubricants as disclosed in my earlier applications to provide an improved polyurethane plastic-abrasive endless belt. Any suitable abrasive particle may be utilized, such as, for example, Carborundum, boron carbide, silicon carbide, tungsten carbide, diamonds and the like.

The abrasive particles may be mixed with any suitable liquid polyurethane plastic that will solidify to produce a hard rubber-like material. Examples of such polyurethane plastics are disclosed in U.S. Patent 2,729,618. In preparing the plastic, an excess of glycol should be utilized over that required to react with all of the carbonyl groups of the dicarboxylic acids in order that the terminal groups of the polyester will be —OH groups. Examples of suitable polyesters include the reaction product of an excess of a diol, such as, for example, ethylene glycol, 1,2-propylene glycol, or other suitable compound having the general formula



in which R may be a divalent hydrocarbon radical or a divalent radical in which the carbon chain is interrupted by —O—, —N—, —S—, or —SO₂— with a dicarboxylic acid, such as malonic acid, succinic acid, adipic acid, methyladipic acid, maleic acid and the like. Many other

suitable glycols and carboxylic acids are disclosed in the aforesaid patent.

The abrasive particles may be wet with the isocyanate or lubricant by any suitable process, such as, for example, spraying the liquid isocyanate or liquid lubricant over the surface of the abrasive particles or by stirring or otherwise agitating the abrasive particles and the isocyanate or lubricant together. For example, the abrasive particles and solid lubricant, such as graphite, may be tumbled together to properly coat the abrasive particles. The resulting pretreated abrasive particles are then mixed with a liquid plastic urethane such as, for example, a molten polyurethane, and then agitating the resulting mixture until a substantially homogeneous dispersion of the particles in the plastic mass is obtained. In making various types of tools of the type disclosed in my aforesaid earlier applications, the mass is poured into a suitable mold and cast into a rubbery elastic state. This casting process is usually brought about by heating the mass while it is confined in the mold for a period of time at an elevated temperature until curing occurs. In one embodiment the plastic mass may be heated for about 24 hours at about 110° C. at which time it will have assumed rubbery elastic properties. The product obtained by such a process has been found to have a surface which contains substantially evenly dispersed exposed particles of abrasive that offer a surface suitable for grinding precision parts to close tolerances. Because of the homogeneity of the product and the properties of the polyurethane plastic, the resulting tool is advantageous for grinding various types of articles where precision is required, such as, for example, for the surfacing of ball bearings, metal working dies, punches and the like.

As disclosed in my earlier applications, if it is desired to produce plastic articles having a relatively thin coating of abrasive particles, the polyurethane plastic mass having the homogeneously dispersed particles of abrasive may be poured over a heated plate and spread out into a thin coating of the desired thickness. This coating may then be cured by any suitable means, such as by heating for about 24 hours at about 110° C. and removed from the plate to provide the thin sheet or ribbon of plastic impregnated with abrasive particles.

In preparing one embodiment of an abrasive article while using an isocyanate to improve the distribution of abrasive particles, about 600 parts by weight Carborundum are coated with a solution of about 10% triphenylmethyl triisocyanate dissolved in a methylene chloride by spraying the solution over the abrasive particles. The resulting wet particles of Carborundum are then mixed with a castable melt of polyurethane plastic prepared from about 1,000 parts of a linear aliphatic hydroxyl polyester having an acid number of about 1, an hydroxyl number of about 50 and a molecular weight of about 200 and about 300 parts 1,5-naphthylene diisocyanate. The polyester-isocyanate reaction product is stirred with about 70 parts by weight 1,4-butanediol until it is completely mixed before it is mixed with the abrasive material. The mixture of polyurethane plastic and abrasive particles is stirred vigorously until the particles of abrasive are substantially uniformly dispersed throughout the plastic mass. The fluid mass is then poured into a mold that has been heated to about 110° C. and the mold and its contents are maintained at this temperature until the mass has cured. Usually about 24 hours will be required for curing the plastic at this temperature. Other curing temperatures may be used but usually the curing time required increases as the curing temperature is decreased.

In an embodiment of the invention disclosed in my earlier applications, about 600 parts by weight commercial grade Carborundum or other suitable abrasive particles are mixed by stirring with about 50 parts of a suitable technical grade silicone oil having a viscosity of about 100 centistokes. The wet particles are then mixed with a polyester-isocyanate mixture of generally the

same composition used in the foregoing embodiment and later about 70 parts 1,4-butanediol are added. The mass is stirred vigorously until a uniform distribution of particles in the liquid polyurethane plastic is obtained. Usually about 30 seconds are required. The liquid mixture is poured into prepared forms such as a suitable mold which have been heated to about 110° C. The mixture is left in the mold, usually for about 24 hours, until the polyurethane plastic has solidified. If thin sheets of plastic having abrasive particles embedded therein are desired, the mass may be poured over the surface of a heated plate and spread into a film or layer of desired thickness.

Referring now to the drawing, in one embodiment of the invention an endless belt 1 may be cast by conventional centrifugal casting methods in any suitable width. The resulting endless belt may then be cut by means of knives or other suitable cutting instruments into a plurality of narrower bands or endless belts 2 as indicated in the drawing. Each of the resulting bands 2 is formed of polyurethane plastic base 3 having abrasive particles 4 embedded therein but exposed at the surface of the belt.

In preparing a polyurethane plastic-abrasive mixture suitable for use in casting endless belts, about 600 parts by weight abrasive particles which may be any suitable abrasive particle, such as, for example, Carborundum, diamond dust, boron carbide, silicon carbide or the like, are mixed with about 50 parts of a suitable dispersing agent, such as, for example, a silicone oil having a viscosity of about 100 centistokes. The resulting wet abrasive particles are mixed with a castable melt of polyurethane plastic prepared from about 1,000 parts of a linear aliphatic hydroxyl polyester having an acid number of about 1, an hydroxyl number of about 50 and a molecular weight of about 200 and about 300 parts 1,5-naphthylene diisocyanate. About 70 parts by weight 1,4-butanediol are added and the mixture stirred until a uniform distribution of particles is obtained. The fluid mass may then be poured into conventional centrifugal casting apparatus and cast into endless belts of polyurethane plastic having abrasive particles exposed at the surface thereof. The cast belt is then cured at a temperature of about 110° C. until the polyurethane plastic has hardened and set. This band may then be cut into narrower widths if desired.

In an alternate method for making endless polishing belts of polyurethane plastic base and having abrasive particles embedded therein but exposed at the surface of the belt, the abrasive particles wet with an isocyanate, silicone oil or other suitable dispersing agent, may be mixed with the liquid polyurethane plastic in the centrifugal casting cylinder.

One of the primary advantages of the polyurethane polishing belt over the cloth belts is that the abrasive particles are distributed throughout the thickness of the belt and the belt can thus be used as it wears and becomes thinner to the point where it is so thin it breaks.

The mechanism resulting in the improved adhesion with an isocyanate is not fully understood but it is believed that the polyisocyanate chemically attaches the particles of abrasive to the plastic, possibly through reaction with —OH groups on the surface of the particles formed by oxidation and hydrolysis and —OH groups in the polyurethane plastic matrix.

By silicone oil is meant any liquid liquid hydrocarbons polysiloxane which has a viscosity of about 50–500 centistokes/20° C. Illustrative examples of silicone oils useful in this invention are dimethyl-siloxane polymers with a viscosity of 50 centistokes/20° C., of 140 centistokes/20° C. and 440 centistokes/20° C.

Although the foregoing embodiment has been described in detail for the purpose of illustration, it is to be understood that variations can be made by those skilled in the art without departing from the spirit and scope of

the invention except as it may be limited by the claims. Other suitable cross-linking agents may be substituted for the 1,4-butanediol including 1,3-propylene glycol, 1,2-propylene glycol, ethylene glycol and the like to bring about curing of the isocyanate-modified polyester. For example, the polyester is preferably prepared from adipic acid and ethylene glycol but any suitable dicarboxylic acid and hydroxy compound may be utilized. Sufficient isocyanate or lubricant is present in the abrasive material if each of the particles has a coating thereof. Any suitable plastic molding process may be used but as stated hereinbefore, centrifugal casting processes are preferred. If the abrasive particles are mixed with the polyurethane melt without first wetting them with a dispersing agent, the finished belt will not have the same degree of homogeneity as the belts made in accordance with the process of the preferred embodiment described above but such belts may be useful in some polishing operations and are superior to the prior art cloth belts.

What is claimed is:

1. A method for making an endless polishing belt having particles of an abrasive embedded therein which comprises wetting abrasive particles with a dispersing agent compatible with a polyurethane melt and selected from the group consisting of a silicone oil having a viscosity of from about 50 to about 500 centistokes at 20° C., graphite, wax, molybdenum sulphide, sulfur and a polyisocyanate having a reactivity with a compound having a reactive hydrogen atom that is at least equivalent to the reactivity of triphenylmethyl triisocyanate with the said compound, mixing the resulting coated particles with a castable melt of a substantially homogeneous polyurethane plastic, casting the resulting mixture into an endless band, and curing the plastic.

2. In a method for making plastic articles having particles of an abrasive embedded therein which comprises mixing abrasive particles with a substantially homogeneous polyurethane plastic in the form of a castable melt, the improvement comprising coating the abrasive particles with a dispersing agent compatible with a polyurethane melt and selected from the group consisting of a silicone oil having a viscosity of from about 50 to about 500 centistokes at 20° C., graphite, wax, molybdenum sulphide, sulfur and a polyisocyanate having a reactivity with a compound having a reactive hydrogen atom that is at least equivalent to the reactivity of triphenylmethyl triisocyanate with the said compound before the abrasive is mixed with the polyurethane.

3. An improved method for making substantially homogeneous polyurethane articles having particles of abrasive embedded therein comprising wetting abrasive particles with a dispersing agent compatible with a polyurethane melt and selected from the group consisting of a silicone oil having a viscosity of from about 50 to about 500 centistokes at 20° C., graphite, wax, molybdenum sulphide, sulfur and a polyisocyanate having a reactivity with a compound having a reactive hydrogen

atom that is at least equivalent to the reactivity of triphenylmethyl triisocyanate with the said compound, mixing the resulting coated particles with a castable melt of a substantially homogeneous polyurethane plastic, and thereafter pouring the resulting mixture into a mold and curing the plastic.

4. The process of claim 2 wherein said particles are coated with a silicone oil having a viscosity of from about 50 to about 500 centistokes at 20° C.

5. The process of claim 2 wherein said particles are coated with a wax.

6. A castable melt suitable for shaping and curing to form a solidified substantially homogeneous polyurethane article having abrasive particles distributed therein and exposed at the surface thereof comprising, abrasive particles coated with a dispersing agent compatible with a polyurethane melt and selected from the group consisting of a silicone oil having a viscosity of from about 50 to about 500 centistokes at 20° C., graphite, wax, molybdenum sulphide, sulfur and a polyisocyanate having a reactivity with a compound having a reactive hydrogen atom that is at least equivalent to the reactivity of triphenylmethyl triisocyanate with the said compound and a substantially homogeneous polyurethane.

7. The process of claim 2 wherein the dispersing agent is graphite.

8. The process of claim 2 wherein the dispersing agent is a polyisocyanate having a reactivity with a compound having a reactive hydrogen atom at least equivalent to the reactivity of triphenylmethyl triisocyanate with the said compound.

9. The process of claim 2 wherein the dispersing agent is sulfur.

10. The process of claim 2 wherein the dispersing agent is a molybdenum sulphide.

11. The process of claim 1 wherein said particles are coated with silicone oil having a viscosity of from about 50 to about 500 centistokes at 20° C.

12. The process of claim 1 wherein said particles are wet with an isocyanate.

13. The belt of claim 14 wherein said particles are Carborundum.

14. An endless belt comprising a substantially homogeneous polyurethane plastic base having particles of an abrasive embedded in the surface thereof.

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