May 15, 1934. W. H. McGILL 1,959,059

GRINDSTONE AND PROCESS OF TREATING SAME

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Fig. 1

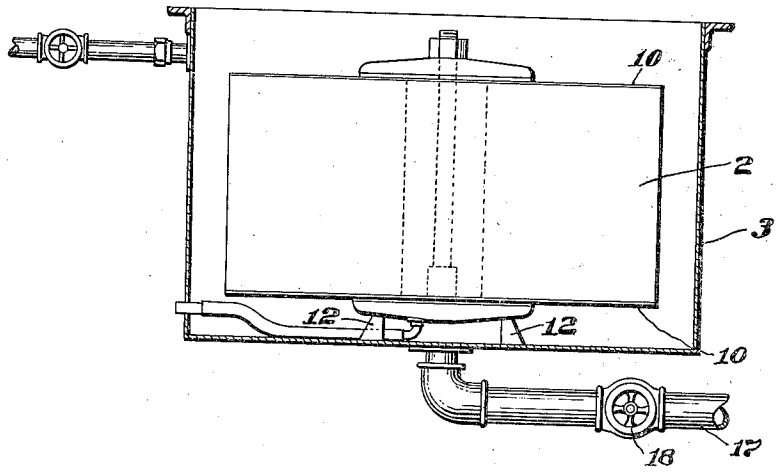
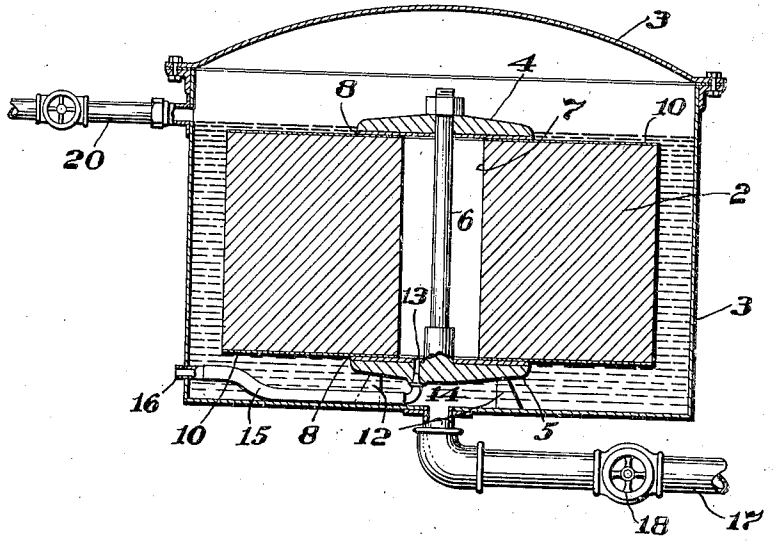


Fig. 2



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GRINDSTONE AND PROCESS OF TREATING SAME

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17 Claims. (Cl. 51—278)

This invention relates to grindstones of the type made from natural stone. It is more especially concerned with grindstones used in grinding wood in the process of making pulp, paper, fiber board, and the like, although it will be evident that some features of the invention can also be used to advantage in grindstones employed for other purposes.

The stones used in pulp grinding machines are of cylindrical form and are of relatively large dimensions. Usually they run from fifty-four inches to sixty-seven inches in diameter and have a grinding face of at least two feet in width, and usually more. A stone sixty-seven inches in diameter and fifty-four inches in width is not uncommon in this industry. Stones of this general character will be hereinafter referred to as "pulp grindstones."

Because of the large size of these stones it is difficult to find deposits of natural stone having the desired grinding characteristics from which to cut grindstones of the desired dimensions. A particularly unfortunate condition is the fact that those quarries in which the larger stones can be cut often yield a stone which does not have the necessary mechanical strength to stand up in use.

The natural stone from which these grindstones are cut is a form of sandstone. When the grindstones are first cut from this material they are soft and "green" and it is the usual custom to put them through a seasoning process which requires several months in the case of large stones. During this process the stone dries out and its mechanical strength and hardness gradually increases, reaching a maximum when the seasoning process has been completed. This seasoning can be done artificially by baking the stones in ovens two to three days at 300° to 325° F.

In the pulp grinding operation the stones are thoroughly saturated with moisture due to the condition under which the wood grinding operation is performed, and the water so applied attacks or weakens the natural bond of the stone so that it loses a very large proportion of its mechanical strength. This loss in strength varies somewhat with different kinds of stones, in fact, some varieties which have very satisfactory grinding characteristics when dry cannot be used in pulp grinding because of the excessive loss of strength which they undergo when wet. It may also be pointed out that the stone in a pulp grinder, in addition to being thoroughly wet during practically its entire life, must also operate at a relatively high degree of heat, this heat being created by the friction of the stone against the wood during the grinding operation. While the temperature so produced will vary with different operating conditions, it will customarily run somewhat under the boiling point of water, say roughly from 160° F. to 200° F., but it will rise above this value under severe conditions. It is not unusual for part of a stone to shell off or blister due to the high temperatures under which it operates, or to sudden changes in temperature.

It is one of the objects of this invention to increase the wet strength of grindstones made of natural stone, and to this end it is proposed to impregnate the stone with suitable waterproofing substances which will protect the natural bond of the stone from the weakening action of water, or at least will materially reduce such action, and which preferably, also, will of itself give added mechanical strength and stability to the natural stone.

It has been proposed heretofore to increase the strength and stability of artificial grindstones by soaking them in a solution of some binder and subsequently drying them out, or even baking them. A long series of experiments has demonstrated that methods of this character cannot be used successfully in grindstones made of natural stone. In fact, I have not been able to learn that they have been successfully used on artificial stones. I have found, however, that the characteristics of natural stone suitable for grindstones are such that they cannot be satisfactorily impregnated with any binder of which I have been able to learn, and which is suitable for the purposes here contemplated, by the methods suggested for the treatment of artificial stones. This is largely due to the fact that the natural stone is far more dense than is the artificial stone, its microscopic pores and cells being much smaller than those in the latter stone. It therefore exerts a high filtering action on any impregnating medium. In addition, the composition of natural stones is not entirely uniform, but there are variations in its structure which introduce serious problems in impregnating such stones on a commercial basis.

To devise a thoroughly satisfactory and reliable method of impregnating grindstones made of natural stone, therefore, forms a further and very important object of this invention.

Referring now to the drawing,

Figure 1 is a vertical, sectional view, partly in elevation, illustrating a step in the process provided by this invention; and

Fig. 2 is a view similar to Fig. 1 but showing additional parts in section, and illustrating another step in said process.

According to the preferred method the grindstone 2 is thoroughly dried to drive out a high percentage of the moisture in it before the impregnating operation is performed. For this purpose it may be baked in a suitable oven and at moderate temperature for a sufficient length of time to heat the stone approximately throughout its mass. Naturally the length of time required for this operation will depend upon the condition of the stone, its size, the temperature used, and the like.

The impregnating operation is conveniently performed in a pressure cylinder or tank of some suitable design, such for example as that shown at 3 in Figs. 1 and 2. Before placing the stone in the tank, heads or plates 4 and 5, respectively, are clamped against the opposite ends of the stone, one of these plates having an integral shaft 6 which extends through the bore 7 of the stone 2 and is threaded to receive a nut for clamping the other plate in position. Gaskets 8—8 of rubber or other suitable material are placed between the end faces of the stone and the plates 4 and 5.

It is preferable to produce a radial impregnation of the stone and for this reason I prefer to size the end surfaces of the stone with a varnish or a coating material of any suitable type which will not be attacked by the impregnating medium and which will prevent said medium from penetrating the stone laterally from the end faces. Such a sizing coat is indicated on an exaggerated scale at 10—10, Fig. 2.

When the stone has been prepared in this manner it is placed in the tank 3, the lower plate 5 resting on bosses 12 located in the bottom of the tank. Preferably the bore 7 of the stone is vented, as for example, by providing a hole 13 through the head 5 and gasket 8, equipping this head with a suitable fitting 14, connecting a tube 15 to this fitting and leading it to a nipple 16 which projects through the wall of the tank.

When these operations have been performed the cover 3' is bolted in place and the impregnating medium then is admitted to the tank through the pipe 17 and valve 18. It is desirable to have the impregnating process follow the baking or drying operation promptly before the stone has had an opportunity to absorb or occlude any substantial amount of moisture and preferably, also, while the stone is still warm so that the microscopic pores and cells on the stone will be as empty as possible. If desired, a preliminary vacuum can be applied after the tank has been closed and before the impregnating liquid is admitted. After the stone has been submerged in the liquid, air is pumped into the tank through the pipe 20 and exerts sufficient pressure on the liquid to force it into the stone. Naturally the temperature at which the liquid is maintained, the pressures used, and the treating period required will depnd upon the conditions surrounding individual cases. In a typical case a pressure of twenty-five pounds is applied for the first half hour and this pressure is stepped up ten pounds at the end of said period and to fifty pounds at the end of an hour, the latter pressure being maintained until the liquid begins to drip through the nipple 16, or, more desirably, until a gallon or two of liquid has run through the nipple. This means that practically the entire volume of the stone has been thoroughly saturated with the impregnating liquid. A stone fifty-four inches in diameter and having a twenty-seven inch face will, in a typical treatment, take about thirty gallons of liquid.

For most purposes it is desirable to leave the stone in a fairly porous condition and to use as little of the impregnating medium as is necessary to give the desired degree of strength to the stone. Consequently, I find it preferable in most cases to withdraw some of the impregnating liquid from the stone after it has begun to run through the vent in sufficient quantity to indicate definitely that the proper degree of impregnation has been effected. This is accomplished by draining the tank and then maintaining a sufficient air pressure, say for example fifty pounds, in the tank until the desired amount of impregnating liquid has been forced out through the vent. For example, in a stone of the size just mentioned from six to eight gallons customarily are withdrawn through the vent after the tank has been emptied.

This procedure has the important advantage of producing a much more uniform impregnation of the stone, notwithstanding natural variations in its structure which must be expected to exist, than could be obtained without the use of this or some equivalent process. It improves the concentration and distribution of treating material at the central portion of the stone, approximately neutralizes the filtering action, partly empties the pores and cells, and avoids the tendency to produce a higher concentration near the periphery of the stone. In effect this part of the process consists in forcing an excessive quantity of treating liquid into the stone and then withdrawing the required proportion of that liquid by forcing it inwardly toward the bore 7. The desired distribution of the impregnating material also is facilitated by sizing the end faces of the stone with varnish or some other material relatively impervious to the impregnating medium and using the gaskets 8—8 with the pressure plates 4 and 5 to hold them in place, this arrangement serving to prevent any short circuiting of the liquid in the stone which otherwise would be likely to occur if these precautions were not taken. Obviously it is not always necessary to size the entire end faces of the stones, the portions of these faces adjacent to the periphery of the stone being left unsized, if desired.

At the completion of the operations above described the stone usually is taken out of the tank and allowed to stand for several hours to drain. It is then heated or baked to drive off the solvent, in the event that one has been used in the impregnating liquid.

The remaining steps of the process will depend upon the nature of the impregnating material employed. I have obtained the best results by using a synthetic resin dissolved in a solvent as the impregnating medium. For example, a phenol-formaldehyde resin dissolved in denatured alcohol preferably with a small percentage, say 10%, of any of the well known plasticizers for such resins, has given particularly satisfactory results. A solution in the proportions of six pounds of alcohol to one pound of resin will penetrate the stone quite readily under the conditions above described even while carrying on the process at room temperatures. With such a material I prefer to bake the stone after it has been impregnated and drained, at a temperature of around, say, 200° F. until nearly all of the alcohol has been evaporated, then to step up the temperature to from 330° F. to 350° F. and to hold it at that point until the resin has been converted into its insoluble and infusible form, it being understood that the resin in the impregnating liquid is in one of its lower phases or stages and should be

converted into a higher stage by heat after the impregnating operation has been completed. In a stone fifty-four inches by twenty-seven inches a baking period of approximately two days at the temperatures above mentioned may be necessary to carry the conversion of the resin to the desired point. With the particular impregnating medium just mentioned a hard gum varnish or cumar resin varnish may be used satisfactorily for sizing the end faces of the stone.

While I have above described one method of procedure which I have found to produce satisfactory results, it will be evident that considerable variation in the steps performed and in the materials used is permissible within the spirit and scope of the invention. For example, a considerable variety of synthetic resins can be successively used in this process. Also, when the normal operating temperatures are not as severe as those used in pulp grinding machines, other impregnating substances such as high melting point waxes, particularly carnauba, candellila and montan may be used, those waxes having a sharp melting point being preferable. Silicate of soda may also be used successfully if the stones are baked sufficiently after the treatment to make the residue waterproof.

It will be evident that the degree of hardness or strength imparted to the stone by this process can be controlled by varying the amount of impregnating material left in the stone. This, in turn, can be regulated by properly controlling the concentration of the solid constituents in the impregnating liquid. Obviously too viscous a liquid cannot be used successfully, but the concentration can be varied very substantially while still producing entirely satisfactory results and affording the desired degree of control.

Such control can also be effected by suitably varying the amount of the impregnating medium which is ejected from the stone after the pressure treatment has been completed. Or, in other words, by governing the degree to which the pores and cells in the stone will be filled with said medium. It should be borne in mind, however, that it is desirable in any event to have the walls of the pores and cells thoroughly coated with the solid constituent of the impregnating agent.

In some cases it may be desirable to have the impregnation confined chiefly to the wearing volume of the stone and this can be done by reducing the time required in the pressure treatment and ejecting a part of the medium by forcing air into the bore of the stone and out toward the periphery. Much better results, however, are obtained by the preferred method above described. It is also possible to reverse the direction in which the impregnating material is introduced, but a better control of the process is effected and more certain and uniform results are obtainable by following the preferred process.

This method enables me to make pulp grinding stones from grades of natural stone which have heretofore been rejected because of their softness and lack of strength. In addition, the fact that the hardness of the stones can be controlled and approximately predetermined by this process is an extremely important practical advantage. When a synthetic resin or equivalent binder is used, any danger of the stone blistering or shelling off is completely overcome since such binders are not affected by any temperature at which the stone can be expected to operate in grinding pulp. Furthermore, since all of the binders above mentioned are waterproof they not only protect the natural bond of the stone but also increase the strength and hardness of the stone due to their own binding effect which is retained substantially unaltered even under very severe operating conditions. It should also be noted that the preferred process above described drives the impregnating medium partly out of the pores and cells of the stone throughout the wearing area thereof so that these pores and cells are partly emptied while the intercellular structure remains coated with the binding material. Consequently, the desired porosity of the stone is maintained notwithstanding the impregnation.

Having thus described my invention, what I desire to claim as new is:

1. A pulp grindstone consisting of natural sandstone impregnated throughout the body thereof with a waterproof binder which retains its binding properties at operating temperatures.

2. A pulp grindstone consisting of natural sandstone impregnated throughout the body thereof with a waterproof binder which remains hard in the stone at operating temperatures up to 180° F.

3. A pulp grindstone consisting of natural sandstone impregnated throughout the body thereof with a sufficient proportion of a waterproof binder to substantially increase the wet strength of the grindstone, said binder being of such a nature as to remain hard in the stone at all temperatures below 180° F.

4. A pulp grindstone consisting of natural sandstone having the walls of the pores and cells thereof throughout the body of said grindstone coated with a waterproof binder which remains hard in the stone at all temperatures below 180° F., said pores and cells being only partly filled with said binder.

5. A pulp grindstone consisting of natural sandstone impregnated throughout the body thereof with a waterproof synthetic resin.

6. That improvement in methods of increasing the wet strength of pulp grindstones made of natural stone which consists in forcing a waterproof binder in a liquid form under fluid pressure into the microscopic pores and cells of the grindstone throughout the greater part of the body thereof while holding the grindstone substantially stationary, and subsequently withdrawing a substantial proportion of the material so introduced to partly empty said microscopic pores and cells while leaving the walls of said cells coated with the impregnating material.

7. That improvement in methods of impregnating grindstones of approximately cylindrical form and provided with a central bore which consists in forcing the impregnating medium under pressure into the stone radially from the periphery thereof toward said bore, and continuing said operation until said medium exudes from the surface of the bore.

8. That improvement in methods of increasing the wet strength of pulp grindstones made of natural stone which consists in impregnating the desired volume of the grindstone with a binder dissolved in a solvent, forcing the solution of said binder under fluid pressure throughout said volume, while holding the grindstone substantially stationary, and subsequently evaporating said solvent.

9. That improvement in methods of increasing the wet strength of pulp grindstones made of natural stone which consists in impregnating the desired volume of the grindstone with a binder dissolved in a solvent, forcing the solution of said

binder under fluid pressure throughout said volume, while holding the grindstone substantially stationary withdrawing from said stone a substantial proportion of the impregnating medium so introduced, and subsequently evaporating said solvent.

10. That improvement in methods of impregnating grindstones of approximately cylindrical form and provided with a central bore which consists in submerging said stone in a body of liquid impregnating medium, venting the bore of the stone so submerged, forcing said medium under pressure through said stone radially thereof until it exudes from the surface of said bore, and preventing any substantial lateral penetration of said medium into said stone in regions adjacent to said bore.

11. That improvement in methods of impregnating grindstones of approximately cylindrical form and provided with a central bore which consists in submerging said stone in a body of liquid impregnating medium, venting the bore of the stone so submerged, forcing said medium under pressure through said stone radially thereof until said medium has penetrated through approximately the entire volume of said stone, preventing any substantial lateral penetration of said medium into said stone in regions adjacent to said bore, subsequently withdrawing said body of impregnating medium, and applying a sufficient gaseous pressure to the impregnated stone to force a substantial proportion of the impregnating medium still held in the stone out through said bore.

12. That improvement in methods of increasing the wet strength of pulp grindstones made of natural sandstone, and provided with a bore, which consists in confining the stone in a closed container, and forcing a binder in a liquid form and under pressure, solely from the periphery of the stone toward said bore, into the microscopic pores and cells throughout the greater part of the wearing volume of said stone while it is so confined.

13. That improvement in methods of increasing the wet strength of pulp grindstones made of natural sandstone, and provided with a bore, which consists in withdrawing the moisture and gases from the microscopic pores and cells throughout the greater part of the body of the grindstone to at least partially empty said pores and cells; submerging the stone so treated, and while the pores and cells thereof are partially emptied, in a bath of binding material in a liquid form; and applying sufficient pressure to said bath to force it, solely from the periphery of the stone toward said bore, into said pores and cells of the stone throughout the greater part of the wearing volume of the stone.

14. That improvement in methods of increasing the wet strength of pulp grindstones made of natural sandstone, and provided with a bore, which consists in withdrawing the moisture and gases from the microscopic pores and cells throughout the greater part of the body of the grindstone to at least partially empty said pores and cells; submerging the stone so treated, and while the pores and cells thereof are partially emptied, in a bath of binding material in a liquid form; and applying sufficient pressure to said bath to force it, solely from the periphery of the stone toward said bore, into said pores and cells of the stone throughout the greater part of the wearing volume of the stone, said binder being of such a nature as to cure under the action of heat, removing the stone from said bath, and subsequently baking the stone so impregnated to cure the binder.

15. That improvement in methods of increasing the wet strength of pulp grindstones made of natural sandstone, and provided with a bore, which consists in confining the stone in a closed container, forcing a synthetic resin dissolved in a solvent under pressure, solely from the periphery of the stone toward said bore, into the microscopic pores and cells of said stone throughout the greater part of the wearing volume thereof while the stone is so confined, said resin being in one of its lower stages, and subsequently heating said stone sufficiently to evaporate said solvent and to convert said resin into a higher stage.

16. That improvement in methods of impregnating grindstones of approximately cylindrical form and provided with a central bore, which consists in forcing the impregnating medium under pressure into the stone in a generally radial direction, inwardly thereof, and closing the stone over annular areas at the ends of the stone, surrounding the opposite ends, respectively, of said bore, against any substantial penetration of said medium laterally into the stone.

17. That improvement in methods of impregnating grindstones of approximately cylindrical form and provided with a central bore which consists in forcing the impregnating medium under pressure into the stone in a generally radial inward direction, continuing said operation until said medium has been forced through the entire radial dimension of the stone, maintaining a substantially greater pressure on said medium at the peripheral surface thereof than at the surface of said bore, and closing annular areas surrounding said bore and located at the end surfaces of the stone against any substantial penetration of said medium laterally into the stone.

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