A roller for operation at a high temperature, for example in a sheet glass making apparatus, comprises a steel shaft and a cylindrical shell on said shaft. The shell consists of fibres of a glassy material, such as basalt, and an inorganic high temperature resistant binder such as silica.

3 Claims, 5 Drawing Figures
ROLLER FOR OPERATION UNDER HIGH TEMPERATURES

The invention relates to a roller capable of operating under high temperatures without melting, cracking, becoming deformed or wearing to such an extent that its working diameter is essentially reduced during use. A particular field of use for such rollers is drawing sheet glass from a melt where the glass passes through a series of roller pairs during the cooling process. It is a particular object of the invention to provide a roller having an improved surface layer. Said surface layer will be referred to as shell in the following specification and claims.

Rollers for this purpose have been manufactured previously with a working shell of cement-bound asbestos. However, these rollers have the drawback that the wear is unsatisfactorily great, thus necessitating frequent replacement and also causing an unhealthy amount of dust. Attempts have been made to improve these rollers by, for instance, partly replacing the asbestos fibres with so-called Fibrefrax or Kaowool, vide U.S. Pat. No. 3,515,531. Although this has produced a certain improvement, these rollers are not completely satisfactory either, since they are still liable to considerable wear and cause substantial quantities of dust.

The inventors considered whether it would not be possible to replace the material forming the shells from some other material which would eliminate the drawbacks to a considerable extent. They came to the idea that the reason for the wear and dust formation must to a great extent lie in the fact that most of the material used contained crystal water which evaporated at the high operating temperatures, thus causing a reduction in the strength of the material, resulting in wear and dust formation.

With this assumption in mind endeavours were made to produce the ceramic shells for the rollers in question from inorganic fibres which do not contain crystal water and to bond these fibres with an inorganic binder which is also free from crystal water. Experiments have shown that this line of thought was correct and gives a solution of the problem.

The fibre materials proposed according to the invention are mineral fibres such as kaolin wool, glass wool, basalt wool, rock wool and slag wool. Kaolin, which is an aluminium silicate with the theoretical formula \( \text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \), can be melted and transformed to long thin fibres by separating a stream of the molten material with the help of a jet of gas. Fibres having a length of at least 5 mm, preferably at least 20 mm, and a thickness of 2 – 5 microns, are preferred. Examples of liquid binders suitable for use in accordance with the invention are colloidal silicic acid and solutions of silicates and phosphates, primarily monocalcium phosphate. The binder should preferably be an aqueous solution or colloidal solution of one of the compounds referred to.

The ceramic shell of the rollers can be produced in the following manner:

1. A strip of a fibre material is wound on a core, the surface of which is preferably coated with a parting agent, for example a plastic to which the binder will not adhere. The thickness of the roller is limited externally by a metal casing, suitably in two halves joined together by a hinge casing so it can easily be removed after forming but before drying of the shell produced. The binder is then poured between the core and the metal casing, and the impregnated fibre material is compressed to the desired density by means of a piston inserted from one end of the casing. The diameter of the casing is sufficiently much larger than the desired final dimension of the roller that after drying and binding the shell can be turned and/or ground to the desired final dimensions. The outer metal casing is removed immediately after the compressing process whereas the core preferably remains in the shell during the drying and binding processes. The core is then removed from the shell, and the shell is mounted on a steel axle which constitutes the shaft of the finished roller. Alternatively, the core may constitute the shaft of the finished roller.

2. Instead of winding a strip around the core, annular discs punched out of a sheet or felt may be used, a plurality of discs being assembled on the core before the impregnation and compression. The ratio between the binder solution and the quantity of fibre material has in this case suitably been found to be 3:1 to 4:1.

A fibre felt is produced in a way known per se, the fibres being oriented substantially in the plane of the felt. A felt is preferred having a thickness of 20 – 30 mm and a density of 100 – 150 kg/m³. Circular discs with a central hole are then cut or punched out of this felt. The discs should have a slightly larger diameter than the desired diameter of the roller. The discs are impregnated with a colloidal solution of silicic acid, suitably containing at least 30 – 50 per cent by weight silicic acid. A suitable product has been found to be the product sold under the trade name Ludox HS-40 and containing 40 per cent by weight silicic acid. One part by weight aluminium silicate fibres is suitably impregnated with 1 – 5 parts by weight of the colloidal silicic acid solution. The wet discs are then applied on a metal rod or a metal tube which will form the shaft of the finished roller. Plates are applied at the ends of the shaft to compress the discs. The roller is placed in a drying chamber and is dried at 90° – 100°C. During the drying process the position of the roller is altered from time to time or continuously so that the colloidal solution is distributed uniformly in the roller. When all the water has evaporated, usually after 24 hours, the temperature is raised to about 110°C and the drying process continues for another 24 hours.

The roller is then turned to the desired diameter. If a roller with particularly low porosity is desired, the turning is interrupted before the desired diameter of the roller has been reached. The roller is then impregnated again with the colloidal silicic acid solution, dried in the manner described previously and finally turned to the desired diameter.

The roller according to the invention can alternatively be composed of several short units. The impregnated discs are then applied in the manner previously described on a core, compressed from the sides and dried to form a unit 20 cm in length, for example, which is then removed from the core. Several such units are applied on a shaft and joined together with the help of a temperature-resistant binder, for example a mixture of burned, powdered kaolin and a colloidal silicic acid solution or an aluminium phosphate solution of water glass as binder. The roller is then turned to the desired diameter.

The final product may be considered either as a bound fibre shell or as a solidified binder reinforced with fibres. The cylinder is suitably made in such a way that the fibres are directed primarily radially. This can
be done by cutting a felted sheet of fibres into strips and winding these strips around a core, as will be described with reference to the accompanying drawing. The amount of binder in the shell for the rollers depends on the structure of the fibre material. Coarser fibres, such as basalt fibres, require a smaller binder content than finer fibres. However, it is quite possible to use a higher percentage of binder for the coarser fibres as well, since the fibres act more as reinforcement of the layer formed by the binder.

When using aluminum silicate fibers and colloidal sillicic acid as binder it has been found that the ceramic shell has a chemical composition corresponding to about 74 % SiO₂ and about 24 % Al₂O₃ at a total porosity of 68 % if it is produced by impregnating the fibre material and compressing it to a density of about 0.75 g/cm³ (in the finished product). This type of covering for the roller can be used at temperatures of up to 1,100°C when drawing sheet glass.

The invention will now be described with reference to the accompanying drawing. FIG. 1 is a schematic view of an apparatus for the manufacture of sheet glass, using rollers according to the present invention. FIG. 2 illustrates a first embodiment of the roller of the invention. FIG. 3 illustrates a second embodiment of the roller of the invention. FIGS. 4 and 5 illustrate the manufacture of the roller of FIG. 3.

The apparatus of FIG. 1 comprises a glass melting furnace 1 and a glass drawing apparatus 2. A sheet 4 of glass is drawn upwardly from the body 3 of molten glass in the furnace 1 through three successive pairs 5 - 7 of support rollers and through a pair of traction rollers 8. The rollers comprise a shaft 9 and a shell or surface layer 10 consisting of fibres and a binder. The shells of the lower rollers 5, which are exposed to a very high temperature, should preferably contain aluminum silicate fibers, whereas the shells of the upper rollers 8 may contain fibres of basalt, for example, which can stand a moderate temperature.

The roller illustrated in FIG. 2 comprises a steel shaft 11, and on said steel shaft a shell or surface layer which consists of three members 12 - 14. Each member has been produced by assembling a plurality of annular discs 15 on a core, impregnating the fibrous discs with a binder as referred to above, compressing the discs in the axial direction, and drying the compressed discs. The adjacent end surfaces of any two members are provided with recessed portions 16 protruding portions 17 engaging said recessed portions. Upon assembling the members 12 - 14 on the shaft 11, a binder is applied between adjacent members to produce a shell having a monolithic structure, and also between the members 12 - 14 and the shaft 11. End walls 19 and clamps 18 are provided at the extreme ends of the shell.

The roller disclosed in FIG. 3 is manufactured by winding strips on a core. The strips 23 are cut from a felt 21 of fibres, vide FIG. 4. The fibres 22 of the felt are mainly oriented along the length of the felt. Such a felt may be produced by allowing fibres to fall upon a moving endless conveyor. The movement of the conveyor makes the fibres place themselves substantially parallel with the direction of movement, i.e., along the length of the felt. The strip 23 is cut in a direction transverse to the length of the felt. Consequently, the cut surfaces 23a will contain the cut ends of the fibres. The strips 23 are now wound on a tubular vertical core 27, vide FIG. 5, so that one of the cut surfaces 23a is adjacent the wall of the core 27. Consequently, the fibres in the strips will be oriented substantially radially relative to the core 27. The core 27 has an annular member 28 fastened to its bottom end, and said member 28 supports an annular end wall 29 having a thicker portion 29a adjacent the core 27. A cylinder 24 surrounds the core 27. The cylinder constitutes of two halves joined to each other by means of flanges 25 and screws 26. When a strip 23 has been wound around the upper portion of the core 27 it is pressed, by means of a tool not shown, down into the annular space between the core 27 and the cylinder 24 so as to abut the annular member 27 which forms the bottom of said annular space. A quantity of liquid binder is now poured into said annular space so as to impregnate the strip. Another strip is now wound on the core 27, pressed down into the annular space, and impregnated with the binder. The process is repeated until the annular space has been filled to the desired height. An annular member 30 is now placed upon the top strip, pressed downward with a pressure required to give the assembled strips the desired density, and fixed in the final position by means of a pin inserted through openings 31 in the wall of the core 27. The outer cylinder 24 is now disassembled and removed. If desired, an extra quantity of liquid binder may now be applied on the surface of the strips. The core with the strips wound thereon is now placed in a furnace and is allowed to dry. The core is now turned in a lathe to the desired diameter. The fibrous product, the shell, is now removed from the core. This operation is facilitated if a parting agent has been applied on the surface of the core before the strip is wound on the core. A desired number of shells 33 - 36 are now assembled on a shaft 32 so that the recessed and protruding end portions 39, 40 produced by the annular members 29, 30 engage each other. Said recessed and protruding portions are removed, however, from the extreme ends of the outer shells 33 and 36. A binder is applied between adjacent shells, and between the shells and the shaft. End walls 37 and clamps 38 are provided at the extreme ends of the finished shell. The roller may, finally, be turned in a lathe, to give the surface of the fibrous shell the desired smoothness.

The following are some examples of the method of manufacture and composition of shells for the rollers in question.

Example 1: Roller having the shell consisting of aluminum silicate fibers and colloidal sillicic acid as binder. A felt is prepared of aluminum silicate fibers and cut into strips having a width of about 5 cm. These strips are wound around a core as disclosed in FIG. 5, and are impregnated with a colloidal sillicic acid solution having an SiO₂ concentration of about 40 percent. The shell is first heated to 90° - 100°C for 24 hours and then finally dried at about 110°C. Finally the roller is ground or turned to the desired dimensions. The roller can be used at a temperature of up to 1,100°C.

Example 2: Roller having a shell of aluminum silicate fibers with aluminum phosphate as binder. The shell is produced in the same way as in Example 1 except that the colloidal sillicic acid solution is replaced by a solution of monoalumunim phosphate. In this case the final drying is performed at such a high temperature, approximately 400°C, and for such a time that the crystal water of the aluminum phosphate disappears.
Example 3: Basalt wool and colloidal silicic acid as binder.

In this case also, strips of the wool are cut and wound around the core and then saturated with binder. The ratio between binder and fibers in the shell is 2:1 to 3:1. The drying, compressing and binding are performed as in Example 1 and a ceramic material is thus produced which can be used at operating temperatures of up to 600°C.

Rollers having shells manufactured in accordance with the examples given above have been tested in the manufacture of sheet glass and it has been found that they give rise to practically no deformation or wear and certainly do not cause any unhealthy formation of dust. This also means that the rollers manufactured in accordance with the present invention can be used for considerably longer than rollers previously manufactured for the same purposes.

The choice of material according to the invention also makes it possible to repair damaged rollers which previously had to be discarded. A paste of the waste from the turning or grinding of the roller to its final dimension and the binder used in manufacturing the roller can be prepared for such repair work. Of course new fibres impregnated with the binder in question can also be used for the same purpose.

What is claimed is:

1. Roller for operation under high temperature consisting essen
tially of a central elongated shaft within a generally cylindrical shell, in which at least the shell consists of (a) a mineral fiber, taken from the group consisting of aluminum silicate wool, glass wool, basalt wool, rock wool and slag wool, the fibers of which are free from crystal water, bound with (b) an inorganic binder taken from the group consisting of SiO₂ and Al₂O₃, which is also free from crystal water.

2. Roller as claimed in claim 1, in which the shell consists essentially of 30–70 percent by weight of fibers and 70–30 percent by weight of colloidal SiO₂.

3. Roller as claimed in claim 1, in which the surface of the shell is turned to a desired diameter and smoothness.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,763,533 Dated October 9, 1973

Inventor(s) Ingvar Gustav Axel Blom et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 48, "mm", both occurrences should read -- cm --.

Signed and sealed this 15th day of October 1974.

(SEAL)
Attest:

McCoy M. Gibson Jr. C. Marshall Dann
Attesting Officer Commissioner of Patents