United States Patent [19]

Sukenik

[11] **3,815,197**

[45] **June 11, 1974**

[54] **GLASS LEHR ROLL AND METHOD OF MANUFACTURE**

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[73] Assignee: **New Hudson Corporation,** New Hudson, Mich.

[22] Filed: **Nov. 8, 1972**

[21] Appl. No.: **304,606**

[52] **U.S. Cl.** **29/132**

[51] **Int. Cl.** **B21b 31/08**

[58] **Field of Search** ..... 29/132, 131, 129.5, 110, 29/125; 65/374, 348, 104; 15/98, 209.5, 209 A, 230, 230.12, 230.19

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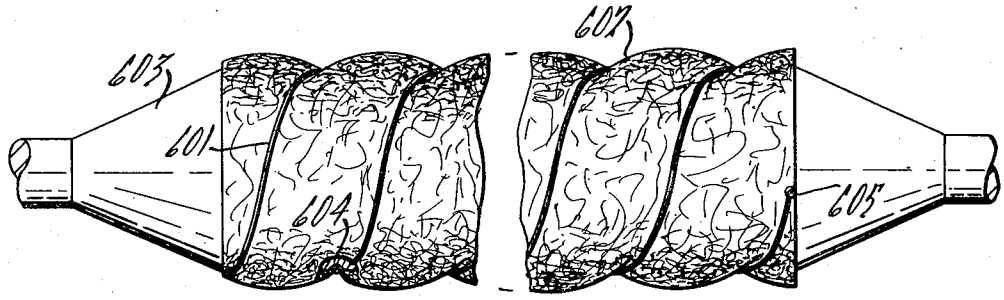
Primary Examiner—Alfred R. Guest

Attorney, Agent, or Firm—Harness, Dickey & Pierce

[57] **ABSTRACT**

A construction and method of manufacture for flat glass annealing lehr rolls having a metal body and a covering of insulating material made from glass, ceramic or metallic fibers. Among the glass and ceramic fibers are amorphous silica, amorphous graphite, ceramic fibers such as "Kaowool" or "Fiberfrax," quartz or mineral wool, metallic fibers, fibermetal or porous metal might be carbon steel, stainless steel or other metals, or alloys such as nickel or bronze. The covering is a temperature-resistant material which is flexible and resilient at lehr temperatures and has a relatively low radial coefficient of thermal conductivity. The covering is relatively thin in most embodiments of the invention, and may be slipped on as a sleeve or applied and secured in other ways.

24 Claims, 19 Drawing Figures



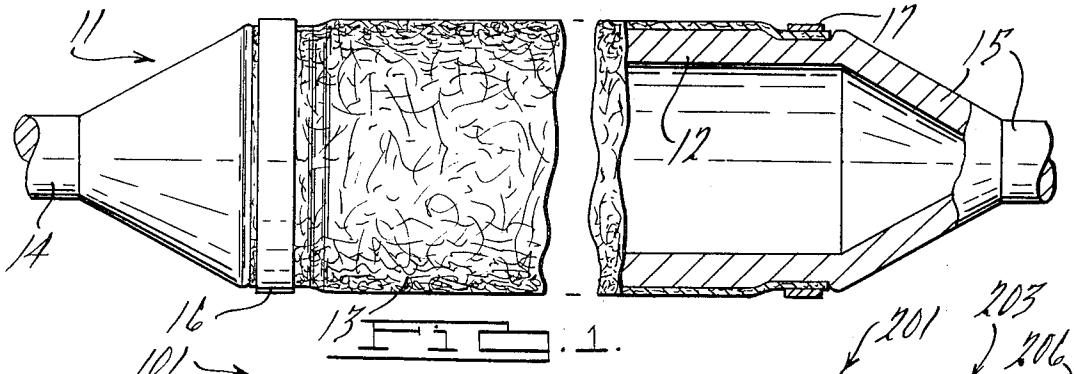


Fig. 1.

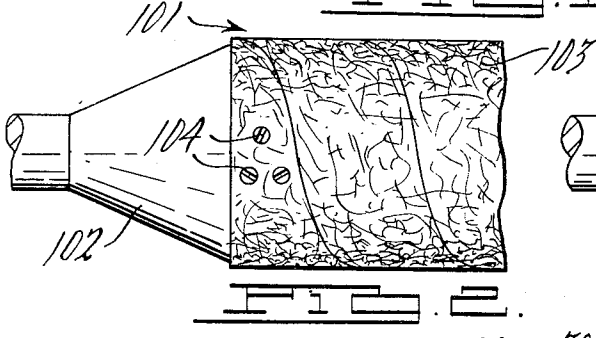


Fig. 2.

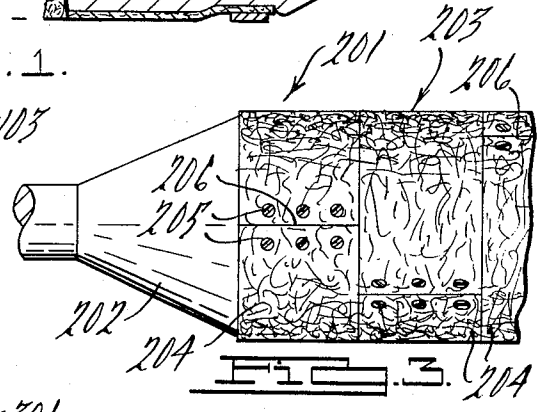


Fig. 3.

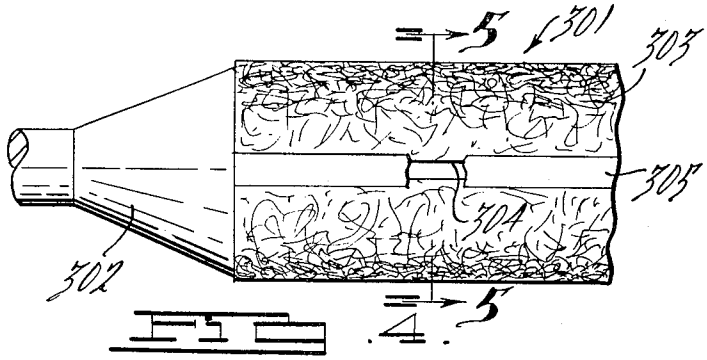


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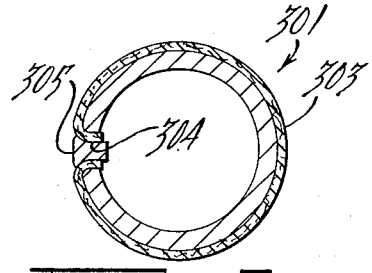


Fig. 5.

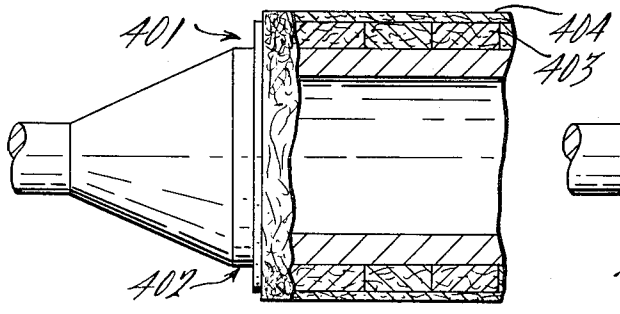


Fig. 6.

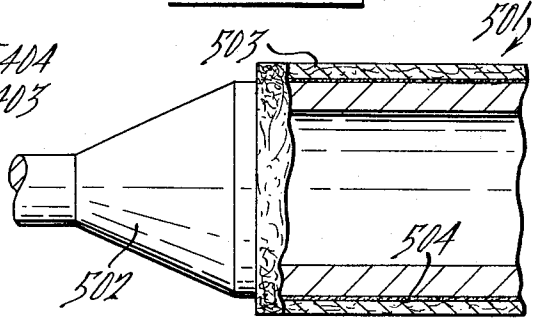


Fig. 7.

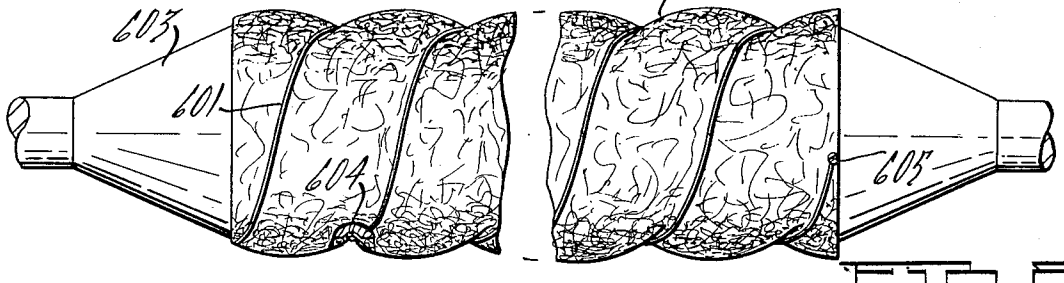


Fig. 8.

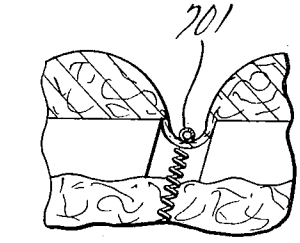


FIG. 9.

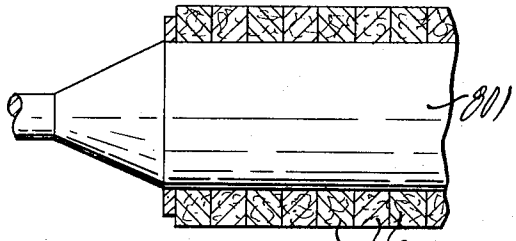


FIG. 10.

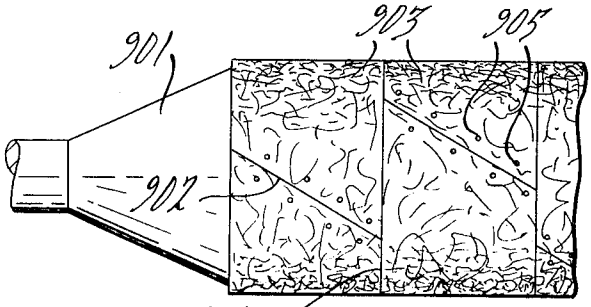


FIG. 11.

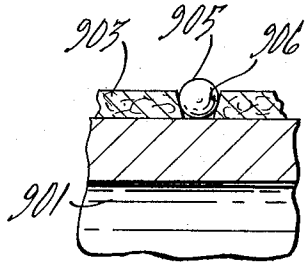


FIG. 12.

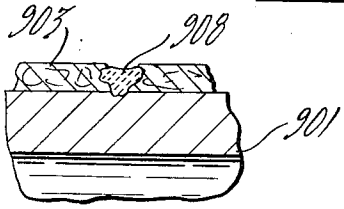


FIG. 13.

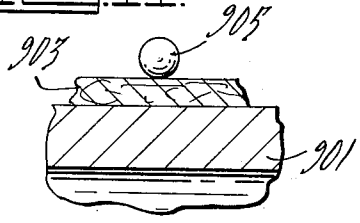


FIG. 14.

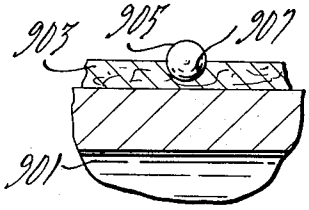


FIG. 15.

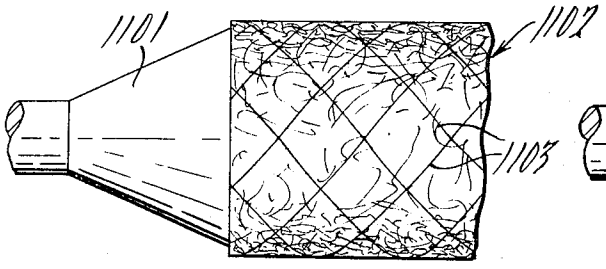


FIG. 16.

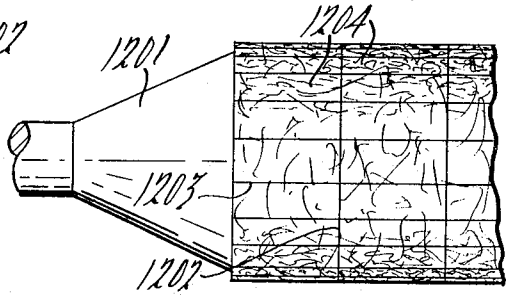


FIG. 17.

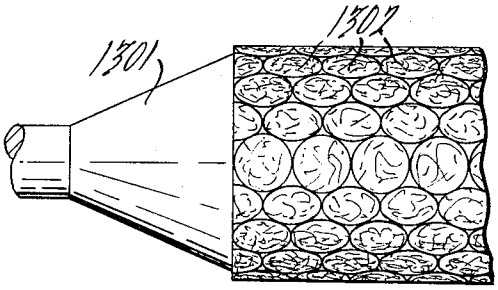


FIG. 18.

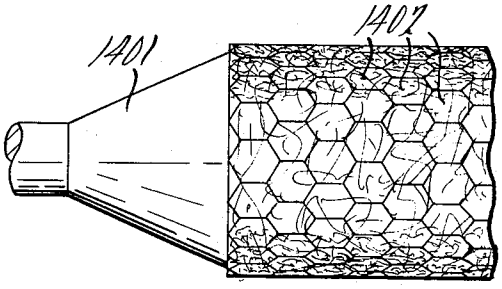


FIG. 19.

GLASS LEHR ROLL AND METHOD OF MANUFACTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to the manufacture of flat glass, and particularly the means for carrying this glass through annealing lehrs.

2. Description of the Prior Art

Rolls for this purpose are presently constructed either of asbestos covered or chrome plated metal. The asbestos covered roll usually comprises annular discs pressed axially together on a mandrel and machined after assembly. Its heat transfer characteristics are satisfactory. However, these rolls are costly and difficult to manufacture and must be machined with appropriate dust control equipment, since asbestos dust is a hazardous material. Asbestos disc rolls also may have significant shrinkage and other changes of dimension, thereby creating an unknown diameter condition in the lehr. In service, the glass may break and abrade the asbestos roll surface, thereby carrying asbestos dust into the plant area unless adequate filtration equipment is provided.

Chrome plated lehr rolls have the advantage of not using asbestos but also have significant drawbacks. At lehr temperatures, the chrome, which is not hard, could be gouged or otherwise damaged by glass breakage, any raised burr marking the glass until removed. Penetration of the chrome will expose the roll to corrosive damage due to sulfur dioxide, tin oxide and other contaminants commonly found in lehr atmospheres. Another undesirable feature of chrome plated lehrs is that the heat transfer resulting from glass-metal contact can have a deleterious effect on the glass by generating local thermal strains. Metal rolls also have a tendency to develop eccentricities in service because of small differences in wall thicknesses or uneven contact with the glass, especially in the mass air cooling zone of the lehr.

The following prior art patents, believed of interest, were discovered as the result of a state-of-the-art search:

3,515,531	Shorr et al.
2,788,957	Lindquist
2,300,528	Sherts
1,593,567	Byrnes
2,794,240	Allen
3,670,381	Schoffmann
1,732,042	Fox
2,313,227	De Bats
2,326,044	Littleton
3,141,756	Griffen
3,404,973	Nedelec
3,492,109	Robinson et al.
1,273,310	Baker
2,062,317	Joseph

The patents listed below were discovered during a novelty search on the method of attaching a fibermetal cover to a metal body (FIGS. 11 to 15):

1,665,762	Waream
3,036,201	Libby
2,262,455	Goodloe
3,214,564	Katzer et al.
2,402,178	Nilssen et al.
3,352,992	Davis
2,495,758	Parker

-Continued

3,437,783	Lemelson
1,039,135	Johnson
3,317,770	Merchant
1,039,137	Johnson
1,039,138	Johnson
3,352,994	Merchant

BRIEF SUMMARY OF THE INVENTION

It is the general object of the present invention to overcome the drawbacks of conventional glass lehr rolls and to provide a novel and improved roll incorporating the advantages of previous known types.

It is another object to provide an improved glass lehr roll of this type which avoids the use of asbestos and its attendant health hazards.

It is a further object to provide a novel glass lehr roll which is relatively inexpensive to manufacture and need not be machined.

It is a further object to provide a glass lehr roll of this nature having a cover which is flexible and resilient at lehr temperatures, has a relatively low radial coefficient of thermal conductivity, and will not generate local thermal strains in the glass.

Briefly, the invention comprises a cylindrical metallic body and a relatively thin covering selected from the group consisting of amorphous silica fabric, amorphous graphite, steel wool, any metallic wool, stainless steel wool, "Kaowool," "Fiberfrax," mineral wool, fibermetal or other porous metal. The body may be metal or in some cases an existing asbestos covered lehr roll. The cover may take the form of a sleeve, sheet, spirally wound tape or segmented covering, and is preferably less than three-eighths inch thick. The covering may be attached to the body by clamps, fasteners, keys, adhesive, wires, welding or other appropriate means.

In the case of amorphous graphite, this material is suited for use in the mass air cooling zone of a lehr and would be approximately 0.005 inches to 0.125 inches thick.

The wool coverings could be secured to the body by adhesives or a binding wire or wires.

The fibermetal or porous metal covering are securable by "dot weld" rivets using pellets of foreign metal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially sectioned side elevational view of a first embodiment of the roll showing a sleeve attached to the body by ring clamps.

FIG. 2 is a fragmentary side elevational view showing a second embodiment of the invention in which the covering is in a form of a wound tape secured by screws.

FIG. 3 is a fragmentary side elevational view of a third embodiment in which the covering is built up of a plurality of strips secured with screws.

FIG. 4 is a fragmentary side elevational view of a fourth embodiment in which the covering is held in place by a key.

FIG. 5 is a cross-sectional view of the embodiment of FIG. 4, taken along the line 5—5 thereof.

FIG. 6 is a fragmentary side elevational view of a fifth embodiment of the invention in which the cover is applied to an existing asbestos covered lehr roll.

FIG. 7 is a fragmentary side elevational view of a sixth embodiment of the invention in which the cover

is bonded to a metal lehr roll with a high temperature ceramic adhesive.

FIG. 8 is a view of a seventh embodiment of the invention in which helically wound fibrous material is secured to the body by a binding wire.

FIG. 9 is a fragmentary view showing the use of a spring instead of a wire to create tension.

FIG. 10 is a view showing the use of stacked radially wound wool discs to form the roll covering.

FIG. 11 is a side elevational view of another embodiment of the invention in which bands of porous metal are secured to the body or substrate.

FIG. 12 is a fragmentary cross-sectional view showing the beginning of one method of securing the porous metal to the body.

FIG. 13 is a view similar to FIG. 12 showing the completion of this method.

FIG. 14 is a view similar to FIG. 12 showing the beginning of another method of securing the porous metal to the substrate.

FIG. 15 is a view similar to FIG. 14 showing still another securing method.

FIG. 16 shows another embodiment of the invention in which the cover material is bonded to a metal roll surface in discrete islands rather than as a continuous surface, the islands in this case being formed by first applying a sheet and slitting the sheet after application.

FIG. 17 is a view similar to FIG. 16 but showing another pattern in which the slits can be made.

FIG. 18 is another embodiment in which round islands of cover material are applied, and

FIG. 19 still shows another embodiment of the invention in which hexagonal islands are applied.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a glass lehr roll generally indicated at 11 and comprising a roll body 12 and a cover 13. Hollow body 12 is fabricated of metal such as carbon or stainless steel and may or may not be chrome plated. The body has extensions 14 and 15 at its opposite ends for its bearing supports.

Cover 13 comprises a relatively thin sleeve which may be of braided, woven, knitted or otherwise fabricated amorphous silica. This material is formed from vitreous silicon oxide fibers and is available, for example, under the trademark REFRASIL manufactured by Hitco of Gardena, Calif. Sleeve 13 is secured at its opposite ends to body 12 by ring clamps 16 and 17. Preferably, the sleeve is less than three-eighths inch thick.

Another type of material which may be used for sleeve 13 is a soft insulated covering of steel wool, stainless steel wool, metal wool, Fiberfrax manufactured by Carborundum Company, "Kaowool" (an aluminum silicate fiber produced by Babcock & Wilcox Co.), quartz, or mineral wool. Still another type of material is amorphous graphite such as "Grafoil" as made by Union Carbide Corporation. Yet another material is fibermetal or other porous metal available in sheet form.

A sleeve 13 of amorphous silica is highly temperature resistant, yet is "soft" (that is, has resiliency and flexibility) at lehr temperatures which are in the neighborhood of 500° to 1,300° F. This material also has a relatively low radial coefficient of thermal conductivity. The thickness of the amorphous silica may be suited to the particular lehr application and a typical example could be one-sixteenth of an inch thick.

The other materials listed above also overcome the drawbacks associated with prior lehr roll surfaces as discussed above, and present a "soft" surface with radial insulating characteristics.

If amorphous graphite is used as the cover material, the roll would be satisfactory for use in the mass air cooling zone of a lehr where the glass is cooled below about 600° F. This material is usable in an oxidizing atmosphere up to 750° F. The amorphous graphite would be in a layer about 0.005 to 0.125 inches thick and will greatly improve the maintenance of lehr roll concentricity during operation by reducing significantly the thermal response of the roll to transient inputs from the glass. A unique characteristic of this material is that it is anisotropic in its thermal conductivity, having poor thermal conductivity through the thickness of the sheet and relatively good thermal conductivity in the surface plane. These characteristics make an ideal combination for a metal lehr roll covering used in the mass air cooling zone.

Amorphous graphite could also be used to improve the characteristics of a glass carrying roll 12 in any portion of a lehr within the temperature limitations of the amorphous graphite. Body 12 would be of steel, aluminum, phenolic, brake block material, urethane, rubber or any elastomer covered with a layer 13 of amorphous graphite 0.005 to 0.125 inches thick. This layer covering acts as an excellent high temperature insulator due to its anisotropic heat transfer characteristics and allows the use of substrate materials which would not ordinarily be able to withstand the surface temperatures. Furthermore, the amorphous graphite is a relatively soft flexible material and presents a surface to glass which is nonscratching. This construction can also be used to provide a soft non-marking surface to any material or to provide thermal "hot spot" resistance to any substrate roll material to allow it to be used to carry a product the temperature of which is higher than the normally accepted tolerance level of the substrate.

In its broadest sense, the invention encompasses various methods of mounting the amorphous silica fabric or other material to the roll. No particular critical surface finishes are required on body 12 so that this body may be manufactured using conventionally metal working techniques. The uniformity of wall thickness for body 12 is not critical so that internal boring operations for the body are not of major importance. The insulating characteristics of cover 13 in a radial direction will minimize any tendency of the roll to alter its true concentricity during operation. Since sleeve 13 is merely slipped over body 12 during manufacture and is not machined after assembly, there is no dust control problem created. The cover will present a soft, pliant yet resilient surface to the glass which is adequately wear-resistant and neutral as regards thermal shock. Because it is relatively thin, the cover will have less tendency to capture and hold any broken glass particles. Moreover, the roll diameter will be predictable because the relatively thin covering will experience less shrinkage.

Maintenance of roll 11 is relatively simple. Broken glass, while tending to tear or gouge cover 13, will not raise any burrs or projections which could mark the glass. Any burrs would have to be raised in the metallic substrate 12, and such burrs would be unlikely to be of

sufficient size to contact the glass. Moreover, any damage to cover **13** may be remedied simply by replacing this sleeve either inside or outside the lehr, but without having to return it to a specialized refurbishing facility.

FIG. **2** illustrates a roll generally indicated at **101** having a body **102** and a cover **103** in the form of a spirally wound tape. This tape may be secured to the body by recessed screw fasteners **104.**

FIG. **3** illustrates a roll generally indicated at **201** having a body **202** and a cover generally indicated at **203** made up of a plurality of strips **204** in axially adjacent relation. Each strip surrounds the body and is secured to by recessed screws on **205,** the junctures **206** of the strips being staggered.

FIGS. **4** and **5** show still another embodiment of the invention generally indicated at **301** having a body **302** and a cover **303.** This cover is composed of a sheet wrapped around the body and having edges which enter a slot **304** in body **302,** the edges being held in place by a key **305.** Although FIGS. **4** and **5** show a key parallel to the axis of the roll, the key could be applied in a helix such as in FIG. **2** or staggered similar to FIG. **3.**

FIG. **6** shows a fifth embodiment of the invention generally indicated at **401** having a body generally indicated at **402** in the form of a typical conventional roll with an asbestos disc cover, the discs being indicated at **403.** To these discs is applied a cover **404** in the form of a sleeve, tape, fabric, sheeting, carpet, or other form of material secured to discs **403** by any suitable means.

FIG. **7** shows a sixth embodiment of the invention generally indicated at **501.** This is a carbon or stainless steel lehr roll body **502** with a cover **503** in the form of a sleeve, tape, fabric, carpet or other woven material. Cover **503** is bonded to body **502** by a high temperature adhesive **504.**

The relative loose primary wool materials listed above may be attached to the body of the roll by two alternative methods. The first method uses a bonding cement of either an elastomer type adhesive such as "Silastic" or refractory cement, depending upon the temperatures involved. The second method is illustrated in FIG. **8** and uses a bonding wire or wires **601** to secure the attached wool **602** to body **603.** It is permissible for the roll to have a quilt-like surface as long as only the soft wool touches the glass. Therefore, the wire or wires **602** which may be either separate groups or one continuous group are imbedded in the wool **602** as shown in FIG. **8.** FIG. **8** is not meant to limit the pattern of the binding wires which for instance, could be oppositely wound helixes, circumferential loops, longitudinal, etc., the object of said binding wires being to hold the wool material to the roll body with sufficient tenacity so that it will not slip out of position. Grooves **604** may be cut in body **603** into which the wires will fit thereby assuring a recessed construction and trapping the wool material to prevent relative movement between the cover and body. The ends of the wire or wires may be secured by a screw **605** or other appropriate means for holding, tensioning, or maintaining tension on the wire. Instead of a wire **601** a helical coil spring **701** (FIG. **9**) could be used to create the tension.

FIG. **10** shows another embodiment of the invention in which a body **801** carries wool discs **802** similar to "floor machine woolers" which are axially stacked and compressed similar to the techniques used in existing asbestos disc covered rolls. "Floor machine woolers" are wound cycloidally with the fibers running primarily in a radial direction. Metal spacers of reduced diameter could be placed between the discs.

FIGS. **11** through **15** show various methods of attaching fibermetal or other porous metal available in sheet form to a body indicated at **901.** This material has a strength advantage with respect to the other materials and is also thermally desirable in that the high void content creates a relatively low coefficient of thermal conductivity. Difficulties in attaching this material to a roll body include differences in coefficients of expansion between the roll body and fibermetal and the necessity of recessing any attachment means so as not to contact a product carried by the roll. Material joints **902** should be cut at a helical angle to provide only point/joint contact with the product, or staggered as in FIG. **3,** and the attachment technique must be secure at high temperatures. Welding a fibermetal is very difficult due to its open characteristics and the tendency to melt back away from the joint. Brazing is difficult due to "wicking" action. Mechanical fastening techniques are difficult and expensive to carry out if the joint is to be helical or recessed. Although axially arranged segments **903** are shown because of the current availability of only relatively small sheet sizes, the invention contemplates the use of larger pieces and different coverage arrangements.

The methods of attachment shown in FIGS. **11** through **15** provide solutions to the aforementioned requirements. According to the basic method, each segment **903** is placed around the body and is secured thereto along joint **902** and also if desired along longitudinal edges **904.** The method of attachment contemplates the use of metal pellets **905** which are placed against segments **903** (FIG. **14**). If desired a small aperture **906** (FIG. **12**) may be formed in segment **903** to receive the pellet or a depression **907** (FIG. **15**) may be used. A welding machine is used to fuse the pellet to body **901** and segment **903** in the manner shown in FIG. **13.** A suitable machine is an impulse welding machine known as a "dot welder" which imparts a timed impulse of electrical energy to pellet **905.** In the process of fusing, the pellet is welded to substrate **901** and the molten metal mushrooms into the adjacent fibermetal **903.** The result is similar to a small protruding rivet **908** welded to the substrate and fibermetal, providing a secure, recessed attachment.

FIGS. **16** through **19** illustrate various methods of fabricating the cover in discrete islands of material rather than as a continuous sheet, for the purpose of limiting damage to the cover in the event one portion is marred. This could occur for example upon glass breakage in the lehr. In FIG. **16,** the roll body is indicated at **1101** and the cover is generally indicated at **1102.** In this case the cover is applied as a sheet or sleeve and is slit along diagonal lines **1103** after application. The cover could be any of the previously mentioned materials bonded to the metal surface of roll **1101.** Cover **1102** may have a woven structure to avoid frayed edges. In the event of damage to any particular segment formed by the slits, that segment may be removed and replaced without the necessity of removing the entire cover.

FIG. 17 shows a similar arrangement with the body being indicated at **1201** and circumferentially and axially extending slits **1202** and **1203** respectively forming discrete islands **1204**. FIG. **18** shows an arrangement in which body **1301** carries islands **1302** of circular shape. FIG. **19** shows a body **1401** having hexagonally shaped islands **1402.**

I claim:

1. A glass lehr roll comprising a cylindrical body, a relatively thin cover formed of material chosen from the group consisting of amorphous silica, amorphous graphite, steel wool, stainless steel wool, metal wool, "Kaowool," "Fiberfrax," mineral wool, metallic cloth, glass cloth, and fibermetal, and means positively securing said cover to said body, said last mentioned means being extraneous to said cover and body.

2. The combination according to claim **1,** said cover comprising a sleeve secured to said body.

3. The combination according to claim **1,** said cover being secured to said body by a bonding cement or adhesive.

4. The combination according to claim **1,** said cover being in the form of discrete islands of material, whereby damage to any one island may be repaired by removing and replacing that island only.

5. The combination according to claim **1,** said cover being wool or a feltlike form and being secured to said body by a bonding cement.

6. The combination according to claim **5,** said bonding cement being an elastomer type adhesive.

7. The combination according to claim **5,** said bonding cement being a refractory cement.

8. The combination according to claim **1,** said cover being wool and secured to said body by at least one bonding wire, and means tensioning said wire or wires whereby the wire will be recessed with respect to the cover surface.

9. The combination according to claim **8,** said body being further provided with grooves for receiving said wire and the portions of the cover therebeneath.

10. The combination according to claim **1,** said cover being wool and secured to said body by a helical spring secured under tension whereby the spring is recessed below the outer surface of the cover.

11. The combination according to claim **1,** said cover comprising a sleeve of amorphous silica secured to said body at both ends by ring clamps.

12. The combination according to claim **1,** said cover being formed as a spirally wound tape.

13. The combination according to claim **12,** said tape being secured to said body by recessed screws.

14. The combination according to claim **1,** said cover being fabricated of a plurality of strips in axially adjacent relation.

15. The combination according to claim **1,** said cover comprising a sheet of material the edges of which enter an axial slot in said body, and a key trapping said edges in the slot.

16. A glass lehr roll comprising a cylindrical metal body and a covering of "fibermetal."

17. The combination according to claim **16,** said fibermetal being provided in the form of axially adjacent segments wrapped around said body.

18. The combination according to claim **16,** further provided with means securing said fibermetal to said body comprising recessed rivet-like members welded to said body and mushroomed into the adjacent fibermetal.

19. A method of applying a fibermetal cover to a metal roll body comprising the steps of wrapping said fibermetal around said roll body and welding metal pellets to said body by the application of electric current in a manner such that the pellet material mushrooms into the adjacent portions of the fibermetal and is recessed with respect to the fibermetal surface.

20. The method according to claim **19,** with the further step of forming recesses in said fibermetal into which said pellets are placed before welding.

21. The method according to claim **19,** further provided with the steps of placing said fibermetal on the body in axially adjacent segments, with the joint for each segment being inclined with respect to the body axis.

22. A glass lehr roll comprising a cylindrical metal body and a covering composed of discrete islands of a high temperature fibrous type of material chosen from the class containing metallic wool, metallic cloth, glass cloth, ceramic fibers, "Kaowool," "Fiberfrax," amorphous graphite, quartz, mineral wool, metallic fibers, and amorphous silica, and means bonding said islands to said body.

23. The combination according to claim **22,** said material having a woven structure.

24. The combination according to claim **22,** said discrete islands being formed by slits in the cover after it is applied.

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