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B. F. ANTHONY
APPARATUS FOR AND METHOD OF PROVIDING A
PROTECTIVE LINING ON A HOT TOP
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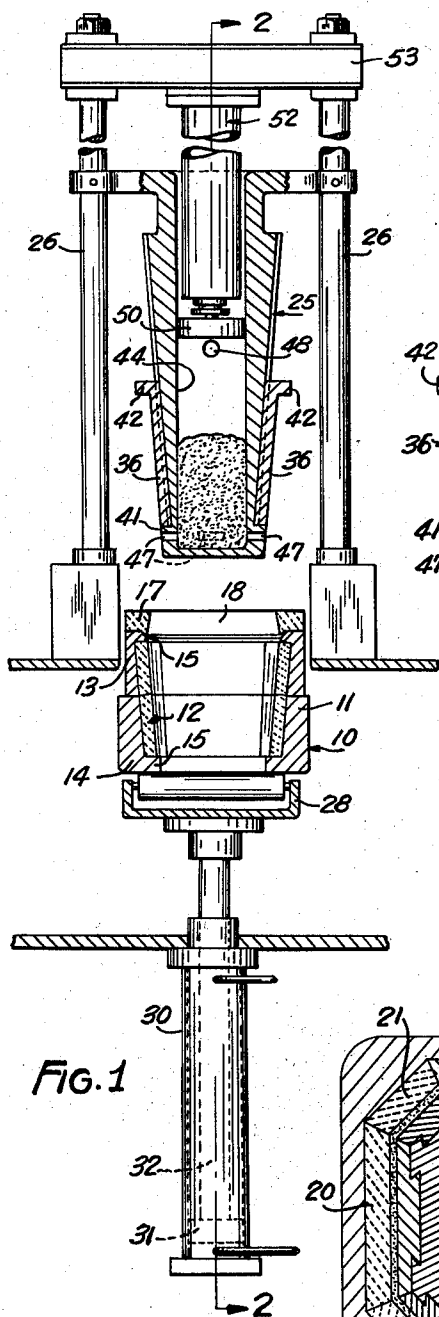


FIG. 1

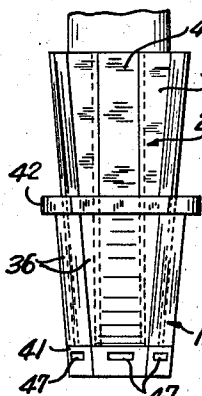


FIG. 4

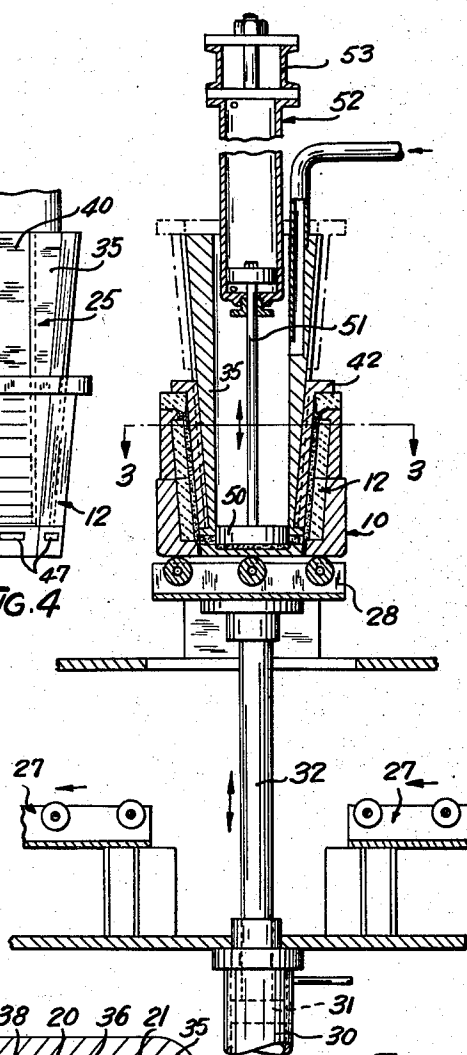


FIG. 2

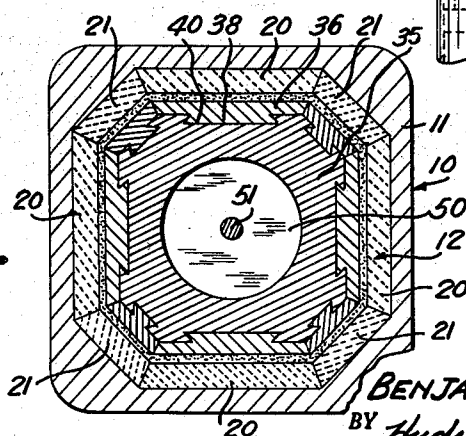


FIG. 3

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APPARATUS FOR AND METHOD OF PROVIDING A PROTECTIVE LINING ON A HOT TOP

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10 Claims. (Cl. 25—22)

The present invention relates to an apparatus and method for applying a protective lining to the inner surface of a hot top.

It is conventional practice in pouring molten steel into ingot molds to use a hot top which is associated with the upper end of the mold into which the metal is poured and when such a hot top is positioned on the mold the molten metal is poured into and through an opening in the hot top into the mold filling the mold and also, to at least some extent, the hot top. When the metal in the mold freezes it will shrink and tend to leave an axial cavity. The hot top is insulated by a refractory lining which forms the interior surface of the hot top so that the metal therein will remain molten sufficiently long to enable the metal in the hot top to feed into the ingot mold to prevent the formation of the cavity.

One form of hot top comprises a casing having a longitudinally tapering opening therethrough, an interior lining of soft insulating fire brick and a layer of protective refractory material on the fire brick lining to protect the fire brick from the molten metal which is poured into the hot top. The protective refractory layer or veneer has to be replaced each time the hot top is used.

In view of the fact that the protective layer must be replaced after each casting, it is desirable that apparatus be provided to facilitate its application. One form of apparatus may comprise a mandrel which is telescoped within the hot top to which the protective layer is to be applied. The hot top is supported in the telescoped relationship by a platform or member which closes one end thereof and the outer surface of the mandrel is uniformly spaced from the inner surface of the hot top, i.e., from the fire brick lining of the hot top, a distance equal to the desired thickness of the protective layer. The material to be applied as the protective layer may then be forced between the mandrel and the fire brick lining to form the protective layer. The mandrel must be subsequently removed to permit the use of the hot top. It has been found, however, that when using the type of apparatus described, the withdrawal of the mandrel as a whole tends to strip the protective layer from the fire brick lining which defeats the purpose of the apparatus.

It is, therefore, an important object of the present invention to provide a new and improved apparatus for, and method of, applying a protective layer to the fire brick lining of a hot top having a tapered opening therethrough, in which apparatus and method a mandrel and a hot top are disposed in telescoped relationship to form a mold for the protective layer and wherein the mandrel and hot top are separated by relative movement of the hot top and mandrel which occurs in such a manner as to prevent the stripping of the protective layer from the hot top.

Another object of the present invention is to provide a new and improved apparatus for applying a protective layer of mobile or plastic refractory material to the fire brick lining of a hot top having an interior wall which tapers inwardly when proceeding toward one end of the

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hot top, in which apparatus a tapered mandrel and the hot top are disposed in telescoped relationship to form a mold for the protective layer and wherein the exterior surface of the mandrel is formed by a plurality of sections which are supported for movement in the plane of the exterior faces of sections, so that the sections may be moved in a direction parallel to the adjacent surface of the emplaced protective layer to separate the mandrel from the protective layer after the formation of the latter.

Further advantages and objects of the present invention will be apparent from the following detailed description of the preferred embodiment hereof made with reference to the accompanying drawings forming a part of the present specification for all matter shown therein and in which:

Fig. 1 is a fragmentary vertical sectional view, with parts in elevation, of the preferred embodiment of the present invention;

Fig. 2 is a fragmentary sectional view with parts in elevation taken approximately along line 2—2 of Fig. 1 and,

Fig. 3 is a sectional view taken approximately along line 3—3 of Fig. 2; and

Fig. 4 is a fragmentary elevational view of the mandrel of the apparatus of Fig. 1.

The present invention contemplates the provision of a new and improved apparatus and method for forming a protective layer of refractory material on the inner surface of a hot top comprised of an open ended casing having an opening therethrough and an inner fire brick lining for the interior of the casing, the side wall of the opening of the hot top tapering inwardly when proceeding toward one end of the hot top, in which apparatus and method a mandrel having a plurality of movable sections forming the exterior surface thereof is disposed in telescoped relationship with the hot top to provide a mold for forming the refractory layer, and when the mandrel and hot top are to be separated after the formation of the protective layer, the sections are moved in a direction parallel to the adjacent face of the emplaced protective layer to first separate the mandrel from the layer.

In the illustrated embodiment, the protective layer of refractory material is to be applied to a hot top 10 which is comprised of an open-ended, hollow casing 11 having an interior lining 12 of fire brick. The opposite end portions 13, 14, of the casing 11 have inwardly turned flange portions 15 which form ledges between which the fire brick lining 12 is supported. A refractory ring or band 17 is detachably connected to the end portion 13 of the casing 11 at the outer side of the adjacent flange portion 15 and has a central opening 18 which is aligned with the central opening of the casing 11. During the casting operation the ring 17 prevents contact of the casing 11 with the hot metal of the ingot and is attached to the casing 11 by any conventional means which do not form a part of the present invention. The end portion 13 is the end of the hot top which rides upon the molten steel in the ingot when the hot top is used and the refractory ring 17 is provided to protect the casing 11 from the heat of the molten metal.

The outside configuration of the illustrated hot top 10 is approximately square in cross section, and the internal side walls of the hot top defining the central opening and formed by the fire brick lining 12 are designated by the reference characters 20, and follow generally the square outside configuration of the top but are joined at the corners by corner shapes which provide corner side walls 21. It will be understood, however, that the hot top opening may have other shapes than that illustrated.

As is best shown in Figs. 1 and 2, the interior side walls 20, 21 taper inwardly toward the longitudinal

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center line of the hot top 10 when proceeding from the end portion 13 of the hot top toward the end portion 14. The fire brick lining may be described as cavity or space within the hot top of truncated pyramidal shape having a cross section at the refractory ring end greater than that at the opposite end.

The apparatus for applying a protective layer of refractory material to the fire brick lining 12 comprises a mandrel 25 having the shape of the opening in the hot top and adapted to be telescoped within the hot top 10 to provide with the interior walls of the hot top a mold for forming the protective layer.

The mandrel 25 is supported in a fixed vertical position, in the illustrated embodiment, by a plurality of vertical stanchions 26. The stanchions 26 support the mandrel 25 in a position above a power driven conveyor 27 which is operable to move the hot top 10 into a position where the hot top and mandrel 25 may be relatively moved into telescoped relationship. The power driven conveyor 27 includes a section 28 disposed immediately below the mandrel 25. The section 28 is supported for vertical upward movement from a position where it is in horizontal registry with the adjacent sections of the power driven conveyor 27 and is moved vertically by the operation of a hydraulic ram 30 having a piston element 31 and a piston rod 32 connected at one end to the piston element 31 and at the other end to the movable section 28. The ram 30 supports the movable section 28 and when fluid pressure is supplied thereto, the piston 31 moves upwardly to elevate the movable section 28 of the conveyor 27.

The hot top to be treated is placed on the conveyor 27 and is moved thereby onto the movable section 28. After the hot top is on the section 28 the ram 30 is operated to elevate the section 28 and the hot top to dispose the mandrel 25 and the hot top 10 in telescoped relationship. The end portion 14 is the section of the hot top where the central opening therethrough has its smallest cross sectional area and the lower end of the mandrel is of a size to fit closely within the opening through the casing at the end portion 14.

The exterior configuration of the mandrel 25 conforms to the interior configuration of the hot top 10 and when the mandrel 25 and the hot top 10 are disposed in telescoped relationship, the exterior surface of the hot top is spaced from the inner surface of the fire brick lining 12 so that a space is provided between the mandrel 25 and the hot top. This space forms the mold cavity for receiving the fictile or plastic refractory material. In the illustrated embodiment the mandrel 25 has the form of a truncated pyramid having eight sides each of which is oppositely disposed and parallel to a respective one of the faces of the fire brick lining 12. The mandrel is comprised of a body member 35 having eight faces corresponding to the sides of the mandrel and each of which supports a respective plate member 36 which form the exterior side walls of the mandrel 25. The plate members 36 are connected to the body member 35 of the mandrel by a respective dovetail way 38 formed on the plate members received in a respective guideway 40 extending longitudinally of the corresponding face of body member 35. The ways 38 and guideways 40 permit the plate members 36 to be moved longitudinally along the body member 35 in the plane of the exterior faces of the plate members 36 and parallel to the adjacent, oppositely disposed faces of the employed protective layer. In the illustrated machine and hot top the wall members extend parallel to the opposite faces of the fire brick lining and are moved parallel thereto. It will be noted that in the type of mandrel to which the present invention relates, the sides of the plate members 36 which form the exterior faces of the mandrel intersect the family of planes containing the axis of the mandrel along straight, parallel lines.

The plate members 36 are movable to lowermost posi-

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tions on the body member 35, as the body member 35 is viewed in Figs. 1 and 2, where they engage a shoulder 41 extending outwardly from the lower end portion of the body member 35. The length of the plate members 36 is such that they extend from the shoulder 41 upwardly through the refractory ring 17. The upper ends of the plate members 36 are provided with outwardly extending flanges 42 which, when the mandrel 25 and the hot top 10 are telescoped, are disposed outwardly of the refractory band 17, and which may be used in effecting movement of the plate members.

The length of the body member 35 of the mandrel is such as to permit the plate members 36 to be moved along the guideways 40 to a position substantially clear of the interior of the hot top 10. In the illustrated embodiment, the length of the mandrel 25 is such that the plate members 36 can be moved to a position above and clear of the refractory band 17. It will be understood, however, that the movement of the plate members 36 need only be sufficient to accomplish the purpose described hereinafter.

With the plate members 36 disposed adjacent the lower end of the mandrel 25 as shown in Fig. 2 and with the hot top telescoped over the mandrel 25 in the manner also illustrated in Fig. 2, fictile refractory material can be supplied from the interior of the mandrel 25 to fill the space between the mandrel 25 and the interior of the hot top. In the illustrated embodiment the body member 35 of the mandrel 25 is provided with a longitudinally extending bore 44. The bore extends to a point adjacent the lower end of the body member 35 and communicates with passages 47 that extend from the opening 44 through the portion of body member 35 forming the shoulder 41 and open into the space between the mandrel and the fire brick lining when the hot top and mandrel are telescoped. The fictile refractory material to be applied as a protective layer enters the mandrel through a port 48 communicating with the bore 44. The material may be supplied by any suitable means connectible to the port. After entering the bore 44 the refractory material is forced from the bore 44 by a plunger 50 disposed in the bore 44 and connected to the piston rod 51 of a fluid pressure cylinder 52 supported by a crosshead 53 extending between the upper ends of stanchions 26. When fluid pressure is applied to the upper end of the cylinder 52 the plunger 50 is moved downwardly to force the refractory material in the bore 44 out through the passages 47 to fill the space between the mandrel 25 and the fire brick lining 12. It will be noted that the interior surface of the refractory ring 17 engages the mandrel 25 to close the upper end of the space between the mandrel 25 and the fire brick lining 12. In addition, the refractory ring 17 will act as a wiper surface when the plate members 36 are removed after molding the protective layer.

After the protective layer has been applied to the interior of the fire brick lining 12, the plate members 36 are first moved longitudinally of the mandrel to separate plate members from the formed protective layer. When the plate members 36 are so moved the forces applied to the protective layer will have substantially no tendency to strip the newly formed protective layer from the fire brick lining 12. After the plate members have been separated from the protective layer, the ram 30 may be operated to drop the hot top clear of the mandrel 25 and to return the section 28 to a position where the hot top can be transferred by the conveyor 27. If the body member 35 and plate members 36 were moved axially to separate the mandrel 25 from the newly formed protective layer, a force component would be applied to the molded layer, by reason of adhesion of the layer to the mandrel, which would tend to pull the newly formed protective layer away from the fire brick lining. By using an apparatus constructed as described, these forces are substantially eliminated and the mandrel and the hot top may be separated with substantially no

tendency to strip the protective layer from the fire brick lining.

The movement of the plate members 36 is effected manually in the illustrated embodiment but may be accomplished by power means, for example by fluid pressure cylinders connected to the frame of the apparatus and to the upper ends of the plate members 36.

It can now be seen that the present invention provides a new and improved method and apparatus for applying a protective layer of refractory material to the inwardly tapering lining faces, which apparatus can be separated from the layer without stripping the same from the lining. While the plate members 36 have been described as moving parallel to the adjacent side of the emplaced protective layer, the movement relative to the body member 35 may have a component which carries them slightly toward the emplaced layer when they are being withdrawn from the hot top cavity.

It can also be seen that the advantages heretofore enumerated and others have been accomplished and, although the present invention has been described in considerable detail, it will be understood by those skilled in the art that it is hereby my intention to cover all modifications and constructions and arrangements which fall within the ability of those skilled in the art and within the scope and spirit of the described invention.

Having thus described my invention, I claim:

1. In an apparatus for applying a layer of plastic refractory material to the side walls of a central opening of a hot top where the central opening extends longitudinally from one end of the hot top where the opening has a maximum cross-sectional area with the cross-sectional area progressively decreasing proceeding inwardly from said one end, a mandrel adapted to be received within the opening to form with the side walls of the opening a mold cavity for the protective layer, said mandrel being comprised of a body member having a portion receivable by said opening and a plurality of wall members each carried by the body member and having an outer surface forming with the other outer surfaces of the other wall members the exterior surfaces of the portion of the mandrel adapted to be received within the hot top, said outer surfaces intersecting a family of planes containing the axis of said mandrel along straight, parallel lines, means for supplying material to the mold cavity formed by the mandrel and hot top to form the layer of the refractory material in the hot top, and means connecting each of said wall members to said body member including a guideway extending parallel to said lines of intersection of the wall member and supporting the wall member for movement longitudinally of said body member and parallel to the plane of the said outer surface thereof to a position substantially clear of said portion.

2. In an apparatus for applying a protective layer of plastic refractory material to the side walls of a central opening of a hot top wherein the central opening extends longitudinally from one end of the hot top where the opening has a maximum cross-sectional area with the cross-sectional area progressively decreasing proceeding inwardly from said one end, a mandrel adapted to be telescoped within the opening to form with the side walls of the opening a mold cavity for the protective layer by relative axial movement between the hot top and mandrel, said mandrel being comprised of a body member and a wall member carried by the body member and forming an exterior surface of the portion of the mandrel telescoped within the hot top and a side wall of the mold cavity, said surface intersecting a family of planes containing the axis of said mandrel along straight, parallel lines, means for supplying refractory material to said cavity to form the layer on the side walls of the hot top, means connecting said wall member to said body member and including a guideway on said body member extending parallel to said lines of intersection

supporting the wall member for movement relative to said body member and parallel to said surface to a position clear of said layer.

3. In an apparatus for applying a layer of plastic refractory material to the side walls of a central opening of a hot top where the central opening extends longitudinally from one end of the hot top where the opening has a maximum cross-sectional area with the cross-sectional area progressively decreasing proceeding inwardly from said one end, a mandrel adapted to be received within the opening to form with the side walls of the opening a mold cavity for the protective layer, said mandrel being comprised of a body member having an end portion adapted to be telescoped with said opening and a plurality of wall members carried by the body member each having an outer side which forms with the outer sides of the other wall members the exterior mandrel surfaces that provide side walls spaced from the side walls of the hot top opening when the mandrel is telescoped within the hot top, said surfaces of each wall member intersecting a family of planes containing the axis of said mandrel along straight, parallel lines, means connecting each of said wall members to said body member and comprising a guideway on said body member extending parallel to said lines of intersection of the wall member supporting the wall member for movement parallel to its said outer side longitudinally of said body member, and means for supporting said hot top and said mandrel in alignment with each other and for relative movement between telescoped and nontele-scoped positions.

4. In an apparatus for applying a layer of plastic refractory material to the side walls of a central opening of a hot top wherein the central opening extends longitudinally inwardly from one end of the hot top where the opening has a maximum cross-sectional area with the cross-sectional area progressively decreasing proceeding inwardly from said one end, a mandrel having a portion adapted to be disposed in said opening in telescoped relationship with said hot top to define with the side walls of said opening a mold cavity for the protective layer to be applied to the hot top, said mandrel comprising a body member and a plurality of wall members corresponding in number to the number of side walls of said opening and each wall member being opposed to a respective one of the side walls of said opening and extending generally parallel thereto to provide spaced walls for forming a portion of the mold cavity, the outer surfaces of said wall members intersecting a family of planes containing said axis along straight, parallel lines, means supporting each of said wall members on said body member of movement relative to said body member and including a guideway on said body member extending parallel to the opposed hot top side wall member on which guideways said wall members are movable relative to each other and relative to said body member from a telescoped position within said opening when said portion is telescoped within said hot top to positions substantially clear of said opening.

5. In an apparatus for applying a layer of plastic refractory material to the side walls of a central opening of a hot top where the central opening extends longitudinally inwardly from one end of the hot top, a mandrel comprising a body member having an end portion adapted to be disposed in said opening in telescoped relationship with respect to said hot top to provide between the mandrel and the side walls of the opening a mold cavity for forming the protective layer of refractory material, said body member having a plurality of side faces corresponding in number to the number of walls of the opening and each disposed opposite a respective side wall of said hot top opening, a wall member supported on each of said faces and having an outer side corresponding in configuration to the configuration of the opposed side wall and intersecting a family of planes containing the axis of said

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mandrel along straight, parallel lines, and guide means connecting each of said wall members to said body member and supporting each of the wall members for movement relative to the other wall members and parallel to its said outer side and along said body member in a direction away from said end portion, said guide means for each wall member extending parallel to said lines of intersection of the wall member supported thereby.

6. In an apparatus for applying a layer of plastic refractory material to the side walls of a central opening of a hot top wherein the central opening thereof extends longitudinally inwardly from one end of the hot top where the opening has a maximum cross-sectional area with the cross-sectional area progressively decreasing proceeding inwardly from said one end, a mandrel comprising a body member having an end portion adapted to be disposed in said opening in telescoped relationship with respect to said hot top to provide between the mandrel and the side walls of the hot top opening a mold cavity for molding the protective layer of refractory material, said body member having a plurality of side faces corresponding in number to the number of walls of the opening and each disposed opposite a respective side wall of said hot top opening, a wall member supported on each of said faces and having an outer side corresponding in configuration to the configuration of the opposed side wall, said outer sides intersecting the family of planes containing the axis of said mandrel along straight, parallel lines, and guide means connecting each of said wall members to said body member and supporting each of the wall members for movement relative to the other wall members and parallel to its said outer side and along said body member in a direction away from said end portion, said guide means for each wall member extending parallel to said lines of intersection of the outer side of the wall member.

7. In an apparatus for applying a layer of plastic refractory material to the side walls of a central opening of a hot top wherein the central opening thereof extends longitudinally inwardly from one end of the hot top where the opening has a maximum cross-sectional area with the cross-sectional area progressively decreasing proceeding inwardly from said one end, said hot top having a refractory band supported on said one end with a central opening therethrough aligned with the central opening of the hot top, a mandrel comprising a body member having an end portion adapted to be disposed in the hot top opening in telescoped relationship with respect to said hot top to provide between the mandrel and the side walls of the hot top opening a mold cavity for molding the protective layer of refractory material, said body member having a plurality of side faces corresponding in number to the number of side walls of the hot top opening and each disposed opposite a respective side wall of the hot top opening, a wall member supported on each of said faces and having an outer side corresponding in configuration to the configuration of the opposed side wall, said sides intersecting the family of planes containing the axis of said mandrel along straight, parallel lines, guide means connecting each of said wall members to the respective face of said body member and supporting each of the wall members for movement relative to the other wall members and parallel

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to its said outer side and along said body member in a direction away from said end portion to clear said end portion, said guide means for each wall member extending parallel to said lines of intersection for the outer side thereof, and abutment means carried by said end portion of said body member for engaging the ends of said wall members to limit the movement thereof in the direction of said end portion.

8. In an apparatus for molding a layer of material on the side walls of an opening in a member where the side walls define a truncated pyramid, a mandrel to be telescoped into said opening to define with the side walls of the opening the side walls of a mold cavity for the layer to be formed, said mandrel comprising a body member of truncated pyramidal shape corresponding to the shape of the opening and having an end portion adapted to telescope within the opening, a plate member supported on each side of said body member in a position on said end portion to form the exterior surface of the mandrel and a side wall of the mold cavity when the mandrel is telescoped into the hot top, and guide means connecting said plate members to their respective sides of the body member for movement therealong parallel to the outer side of the respective plate members and relative to each other to positions substantially clear of said end portion of said body member.

9. The method of forming a layer of material on the side walls of a tapered hot top opening comprising forming a mold cavity for said layer by inserting a tapered mandrel into said opening, supplying moldable material to said cavity, moving the surfaces of the mandrel forming the side walls of the mold cavity relative to the mandrel proper and along and parallel to the adjacent face of the molded layer into positions substantially clear of the molded layer to disengage the mandrel from the layer, and then removing the mandrel proper from the opening.

10. The method of forming a layer on the side walls of a tapered hot top opening having a polygonal cross section, disposing in said opening a tapered mandrel having planar sides corresponding in configuration to the side walls of said opening to provide a mold cavity between the outer sides of the mandrel and the side walls of the hot top opening, supplying moldable material to said mold cavity, disengaging the mandrel from the mold cavity by moving the portions of the mandrel providing said sides thereof parallel to the planes of the sides and relative to the mandrel to substantially clear the portions from the molded layer, and removing the mandrel proper from the opening.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,942,319

June 28, 1960

Benjamin F. Anthony

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 74, strike out "and" and insert the same after "intersection" in line 75, same column 5; column 6, line 24, strike out "and" and insert the same after "member" in line 26, same column 6.

Signed and sealed this 20th day of December 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents