Abstract:
A system for the continuous molding and curing of tread for tires. A plurality of discrete mold assemblies are conveyed adjacent to each other. As the mold assemblies are advanced sequentially, a plurality of blade assemblies cut a continuous, elongated strip of rubber material into sections or strips of a certain length. The strips are molded, joined, and cured to create another continuous, elongated strip of rubber material that can be cut into the desired lengths for joining to a tire carcass.
SYSTEM WITH BLADE ASSEMBLIES
FOR
CONTINUOUS MOLDING AND CURING OF TIRE TREAD

FIELD OF THE INVENTION
[0001] The subject matter of the present disclosure relates generally to a system for the continuous extrusion, molding, and curing of tread for tires.

BACKGROUND OF THE INVENTION
[0002] Conventional methods for the manufacture of tire tread include a multiple step, non-continuous process. Typically, a rubber strip having a desired cross-sectional profile is extruded from a rubber-based formulation that is referred to herein as rubber or a rubber material. The rubber material typically includes a variety of components such as functional elastomers, resins, carbon black fillers, non-carbon black fillers, and/or other substances. As part of the extrusion process, the rubber is heated and fluidized. Pressure from the extruder screw forces the rubber through a die on the extruder outlet that imparts the desired profile to the rubber strip. For example, the strip may be flat, have tapered sides, and include one or more ribs extending along its length. The extruded rubber strip is then wound and stored. Heat energy from extrusion process is usually lost as the rubber cools during the subsequent handling and storage.

[0003] In order to apply a tread pattern, the rubber strip is unwound, cut to length, and positioned as separate pieces into a mold. Placement of each strip onto the mold requires carefully positioning each piece into the mold individually. Such placement may be performed in a manually intensive process that requires movement of the
relatively heavy rubber strips. As part of the molding process, each rubber strip is reheated in the mold in order to cure the rubber and facilitate the molding of tread features into the rubber strip.

[0004] The resulting strips of tread rubber are then removed from the mold. Again, this may be performed manually. Each strip of tread rubber may then be stored again until it is applied to a tire carcass. Joining the tread strip with the tire carcass can require additional heating for completing the curing process and affixing the tire to the carcass.

[0005] Such conventional, non-continuous processing for creating the tread is inefficient. The process is referred to as non-continuous because the material is stored between the extrusion and molding steps for a time period sufficient to allow the material to cool to ambient conditions. The loss of heat energy after extrusion means additional energy expense must be incurred in order to reheat the rubber for subsequent molding and curing. The storage and handling of the rubber in between extrusion and molding adds additional expense in the form of labor and space. Additionally, heating the same rubber strip multiple times requires careful temperature control over specific time periods in order to ensure the proper overall amount of curing is achieved.

[0006] Accordingly, a system for the extrusion, molding, and curing of rubber to manufacture tread for tires would be useful. A system that can reduce or eliminate storage and reheating of the rubber between extrusion and molding would be beneficial. Such a system that can perform these operations continuously would be particularly useful.

**SUMMARY OF THE INVENTION**

[0007] The present invention provides a system for the continuous molding and curing of tread for tires. A plurality of discrete mold assemblies are conveyed adjacent to each other. As the mold assemblies are advanced sequentially, a plurality of blade assemblies cut a continuous, elongated strip of rubber material into sections or strips of a certain length. The strips are molded, joined, and cured to create another continuous, elongated strip of rubber material that can be cut into the desired lengths.
for joining to a tire carcass. Because the rubber material is molded and cured shortly after extrusion, the material retains much of the heat energy of extrusion and storage between extrusion and molding/curing can be avoided. Additional objects and advantages of the invention will be set forth in part in the following description, or may be apparent from the description, or may be learned through practice of the invention.

[0008] In one exemplary aspect, the present invention provides a method for continuous molding and curing of tire tread using movable mold assemblies arranged adjacent to each other along a conveying direction. The method includes positioning a first strip of rubber material onto a first plurality of mold assemblies located between a plurality of blade assemblies, the first strip of rubber material including an upstream end and a downstream end; forcing the first strip of rubber material against the first plurality of mold assemblies and one or more of the plurality of blade assemblies; cutting the upstream end, the downstream end, or both, from the strip of rubber material; advancing the first plurality of mold assemblies and the first strip of rubber material along the conveying direction; joining the downstream end of the first strip of rubber material with an upstream end of a second strip of rubber material; and pressing the first and second strips of rubber material.

[0009] In another exemplary embodiment of the present invention, an apparatus for the continuous molding and curing of tire tread is provided. The apparatus defining a longitudinal axis. The apparatus includes multiple mold assemblies movable along the longitudinal axis, each mold assembly have an upstream end and a downstream end. A mold assembly transport mechanism is arranged along the longitudinal axis and is configured for moving mold assemblies along a conveying direction. The mold assembly transport mechanism has an in-feed end and an out-feed end.

[0010] A lower platen assembly extends along the longitudinal axis. A first upper platen assembly is positioned near the infeed end of the mold assembly transport mechanism, the first upper platen assembly selectively movable along a vertical direction relative to the lower platen assembly. A second upper platen assembly is positioned adjacent and downstream of the first lower platen assembly, the second
upper platen assembly selectively movable along the vertical direction relative to the lower platen assembly.

[0011] A first blade assembly is selectively movable between i) a first position in contact with the upstream end of a first plurality of the mold assemblies and below the first upper platen assembly and ii) a second position retracted from contact with the upstream end of the first plurality of mold assemblies;

[0012] A second blade assembly is movable among i) a first position in contact with the downstream end of the first plurality of mold assemblies and below the second upper platen assembly and ii) a second position retracted from contact with the downstream end of the first plurality of mold assemblies; and

[0013] A third blade assembly is movable among i) a first position in contact with the upstream end of a second plurality of the mold assemblies and below the second upper platen assembly and ii) a second position retracted from contact with the upstream end of the second plurality of mold assemblies.

[0014] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0015] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0016] FIG. 1 illustrates a perspective view of an exemplary apparatus of the present invention.

[0017] FIG. 2 illustrates a side or elevation view of the exemplary apparatus of FIG. 1.

[0018] FIG. 3 provides a top view of the exemplary apparatus of FIG. 1.

[0019] FIG. 4 is a perspective view of an exemplary molding assembly of the present invention.
FIGS. 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23 are side views of an exemplary molding press and exemplary curing press of the present invention and illustrate various steps as further described herein. Only an upstream portion of the curing press is shown.

FIGS. 6, 8, 10, 12, 14, 16, 18, 20, and 22 are top views of exemplary molding assemblies and blade assemblies of the present invention and illustrate various steps in conjunction with FIGS. 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23, respectively.

**DETAILED DESCRIPTION**

For purposes of describing the invention, reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment, can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

An exemplary apparatus 100 for the continuous molding and curing of tread rubber for tires is illustrated in perspective, side, and top views of FIGS. 1, 2, and 3, respectively. Apparatus 100 includes a molding press 110, a curing press 112, and several other mechanisms - the features and operation of which will be further described herein with reference to exemplary embodiments and methods of operation. Along its length, apparatus 100 defines a longitudinal axis L. Arrow F represents a conveying direction or the overall direction of flow of rubber material forming the tread.

Pairs of figures, including FIGS. 5 and 6, FIGS. 7 and 8, FIGS. 9 and 10, FIGS. 11 and 12, FIGS. 13 and 14, FIGS. 15 and 16, FIGS. 17 and 18, FIGS. 19 and 20, FIGS. 21 and 22, and FIGS. 23 and 24 are used to depict various steps in an
exemplary method of operation of apparatus 100. For each pair, the top figure depicts
a side view of molding press 110 and a portion of curing press 112 while, for the same
step or steps, the bottom figure depicts a top view of the position of multiple molding
assemblies 114 as well as the positions of a first blade assembly 154, a second blade
assembly 156, and a third blade assembly 158.

[0025] Referring generally to FIGS. 1, 2, and 3, a continuous and elongated strip
of extruded rubber material 94 enters an infeed end 106 of apparatus 100 as uncured
or green rubber material that has not yet been molded with desired tread features.
Apparatus 100 can be operated without requiring strip 94 to be stored in e.g., rolls
and/or experience the concomitant heat loss of such storage before molding and
curing. Rubber strip 94 is cut into multiple strips 94_s that are sequentially molded and
cured as such are fed and advanced along the conveying direction F through a
molding press 110 and then a curing press 112. After molding and curing by
apparatus 100, a continuous and elongated strip 98 of processed rubber material exits
outfeed end 118 in a cured state with tread features molded therein.

[0026] Apparatus 100 includes an extruder or extrusion machine 102 positioned
near the in-feed end 106. Extruder 102 receives one or more rubber materials and
uses a rotating screw to mix and masticate the rubber materials under elevated
pressures and temperatures to create the continuous, elongated strip of rubber material
94. One advantage of the present invention is that a variety of different rubber
materials may be extruded and molded using the same apparatus 100 to provide a
variety of treads requiring e.g., different processing conditions and/or dimensions.

[0027] The masticated rubber material exits extruder 102 through extruder outlet
108. A die may be included with extruder outlet 108 to impart an overall shape or
profile to the continuous, elongated strip of rubber material 94. Rollers 120 allow for
compensation loops 96 in rubber strip 94, which can be used to ensure that a sufficient
supply of rubber strip 94 is constantly available to apparatus 100 irrespective of the
rate of output from extruder 102.

[0028] At a cutting station 92, rubber strip 94 is cut into smaller, individual
sections or strips 94_s of uncured and unmolded rubber material. Strips 94_s are then
consecutively fed, one at a time, along longitudinal direction L to molding press 110.
A variety of different mechanisms may be used to cut continuous rubber strip 94 into sections or strips 94s as will be understood by one of ordinary skill in the art using the teachings disclosed herein.

[0029] FIG. 4 provides a partial perspective view of an exemplary mold assembly 114. From cutting station 92, rubber strips 94s are sequentially placed onto mold assemblies 114 in molding press 110 as will be further described. For this exemplary embodiment, each mold assembly 114 includes a mold sector 138 positioned along transverse direction T between opposing mold support rails 140. Rubber strips 94s are received onto the mold surfaces 142 of multiple adjacent mold assemblies 114 along longitudinal axis L of apparatus 100. Although not shown, mold surface 142 includes features for molding a tread pattern into the rubber material. Mold sector 138 and support rails 140 are each connected to mold back 146.

[0030] Adjacent mold assemblies 114 can be selectively locked and unlocked or otherwise connected together to facilitate movement along longitudinal direction L. With reference to flow direction F (which points from an upstream position to a downstream position), each mold assembly 114 includes an upstream end 150 and a downstream end 152. These ends are configured to mate in a complementary manner when the mold assemblies 114 are positioned adjacent to each other and travel in process direction F along longitudinal axis L (e.g., FIG. 6).

[0031] With rubber material carried thereon, mold assemblies 114 move together as such are advanced by a mold assembly transport system 104 (e.g., FIGS. 1, 3, and 6 through 20) along process direction F through molding press 110 and then curing press 112. Mold sector transport mechanism 104 extends along longitudinal direction L between infeed end 106 and outfeed end 118. For this exemplary embodiment of mold assemblies 114, mold backs 146 are provided with a pair of opposing notches 163 that are used by the mold sector transport system 104 to pull mold assemblies 114 along process direction F.

[0032] The construction for mold assembly 114 is provided by way of example only as other constructions may be used as well. For example, mold assembly 114 may be constructed as an integral element with or without backs 146 and rails 140. Similarly, a variety of different mechanisms other than notches 163 may be used to
move mold assemblies 114 along conveying direction F by transport mechanism 104. For example, transport mechanism 104 can include motorized rails, conveying chains, and/or other mechanisms to push, pull, or otherwise convey mold assemblies 114 along apparatus 100.

[0033] As shown in FIGS. 6, 8, 10, 12, 14, 16, 18, 20, and 22, mold assemblies 114 are translated by mold assembly transport mechanism 104 along a lower platen assembly 116. Lower platen assembly 116 may include one or more platens extending through and/or between mold press 110 and curing press 112. Lower platen assembly 116 provides one or more surfaces against which mold assemblies 114 containing strips 94s of rubber material and elongated rubber strip 98 (created from strips 94s as will be further described) are forced or pressed as part of molding and curing with apparatus 100.

[0034] For this exemplary embodiment, the vertical position (vertical direction denoted by arrows V) of lower platen assembly 116 is fixed. Other configurations may be used as well. All or portions of lower platen assembly 116 can be equipped with features for heating the rubber material as it passes along apparatus 100. For example, lower platen assembly 116 may be provided with internal passages for the flow of a heat transfer fluid pumped therethrough.

[0035] In molding press 110, the rubber material is positioned on one or more mold assemblies 114 under a first upper platen assembly 122. In curing press 112, the rubber material is positioned on a plurality of mold assemblies 114 under a second upper platen assembly 122. Platen assemblies 114 and 122 may each include one or more individual platens.

[0036] First upper platen assembly 122 in molding press 110 and second upper platen assembly 124 in curing press 112 are each independently movable along vertical direction V relative to lower platen assembly 116. For example, first upper platen assembly 122 can be lowered against one or more strips 94s of rubber material in mold assemblies 114 in molding press 110 to apply pressure and heat to mold tread features into the rubber. As the mold assemblies 114 are advanced along conveying direction F, second upper platen assembly 124 can be lowered against rubber strip 98 (formed by joining strips 94s as will be further described) on a plurality of mold
assemblies 114 in curing press 112 so as to apply pressure and heat to continue curing rubber strip 98. Both platen assemblies 122 and 124 can be raised together or independently in order to allow rubber material on mold assemblies 114 to be advanced along flow direction F by mechanism 104 and to allow for release of trapped gases in the rubber material.

[0037] A plurality of motors 126 and 128 can be used to raise and lower platen assemblies 122 and 124, respectively. Motors 126 and 128 can be constructed as e.g., individually controlled hydraulic cylinders. As will be further described, the operation of motors 126 and 128 are synchronized with each other and the movement of rubber strips 94, and rubber strip 98 through mold press 110 and curing press 112. As with lower platen assembly 116, each of the upper platen assemblies 122 and 124 can be equipped to apply heat to the rubber materials as such move through apparatus 100. A frame 130 supports the platen assemblies and motors.

[0038] Before curing in press 112, rubber strip 98 may be tacky. A roll 134 (FIGS. 1 and 2) of anti-stick fabric 136 may be placed between rubber strip 98 and second upper platen assembly 124 along apparatus 100. Fabric 136 moves with rubber strip 98 as it passed through apparatus 100 along conveying direction F. For some rubber formulations, upper platens 122 and 124 may need to be cleaned even with use of the anti-stick fabric after a certain amount rubber material passes through. Other methods of preventing rubber strip 98 from sticking to the platen assemblies may be used as well.

[0039] For this exemplary embodiment of apparatus 100, the length along longitudinal direction L of curing press 112 is significantly longer than the length of molding press 110. For example, curing press 112 could have a length along longitudinal direction L of about 10 meters while mold press 110 has a length along longitudinal direction L of about 1.5 meters. Other lengths and relative sizes may also be used.

[0040] An exemplary method of the present invention using exemplary apparatus 100 will now be set forth. Using the teachings disclosed herein, one of skill in the art will understand that the exemplary method may be used with other exemplary apparatuses of the invention as well to provide additional exemplary methods. As
used herein, the term "method" or "process" refers to one or more steps that may be
deprecated from the scope of the
presently disclosed invention. As used herein, the term "method" or "process" may
include one or more steps performed at least by one electronic or computer-based
apparatus. Any sequence of steps is exemplary and is not intended to limit methods
described herein to any particular sequence, nor is it intended to preclude adding
steps, omitting steps, repeating steps, or performing steps simultaneously. As used
herein, the term "method" or "process" may include one or more steps performed at
least by one electronic or computer-based apparatus having a processor for executing
instructions that carry out the steps.

[0041] Referring now to FIGS. 5 and 6, molding press 110 is shown in an open
position in which the first upper platen assembly 122 is raised along vertical direction
V away from lower platen assembly 116. A first plurality of mold assemblies 114p,
including what will be referred to as first mold assembly 114p, are in a preliminary
position in preparation for movement along flow direction F onto lower platen
assembly 116 at a position under first upper platen assembly 122. First blade
assembly 154 is positioned in contact with an upstream end 150 of first molding
assembly 114f.

[0042] Curing press 112 is shown in a closed position in which second upper
platen assembly 124 has been lowered along vertical direction V to press against the
continuous, elongated strip of rubber material 98 that is positioned on a second
plurality of molding assemblies 114sp, which includes what will be referred to as
second mold assembly 114s. Only a portion of the second plurality of molding
assemblies 114sp are shown as such continues downstream along curing press 112 and
longitudinal direction L. Curing press 112 applies heat and pressure to cure (partially
or completely) the continuous strip of rubber material 98. As will be further
described, tread features have already been molded into strip 98 by molding press
110. Strip 98 is created by joining individual rubber strips 94s.

[0043] As shown in FIGS. 5 and 6, third blade assembly 158 is positioned against
second mold assembly 114s and upstream end 160 of the second strip of rubber
material 98. Third blade assembly 158 is also located between the second upper
platen assembly 124 and lower platen assembly 116. In this first position, third blade assembly 158 prevents the backflow of rubber material 98 that could occur as a result of the pressure applied to the second strip 98 by second upper platen assembly 124.

[0044] In FIGS. 7 and 8, as depicted by arrows A, the first plurality of mold assemblies 114p have been advanced along flow direction F by mold assembly transport mechanism 104. As such, this places the first plurality of mold assemblies 114p under first upper platen assembly 122 and over lower platen assembly 116. Notably, first blade assembly 154 remains in contact with an upstream end 150 of the first plurality of mold assemblies 114p and second blade assembly 156 is in contact with a downstream end 152. As shown in the top view of FIG. 8, blade assemblies 154, 156, and 158 each have a shape or profile for complementary receipt of the upstream and downstream ends 150,152 of the molding assemblies 114. For the operations depicted in FIGS. 7 and 8, molding press 110 remains open while curing press 112 remains closed. Blade assemblies 154 and 156 are also configured for cutting rubber material as will be described.

[0045] Next, a first strip of rubber material 94s is placed onto the first plurality of mold assemblies 114p between first blade assembly 154 and second blade assembly 156 as illustrated in FIGS. 9 and 10. The first strip of rubber material 94s is provided from cutting station 92 and its length along longitudinal direction L exceeds the length between first blade assembly 154 and second blade assembly 156. As such, the upstream end 166 and downstream end 168 of the first strip of rubber material 94s lay over blade assemblies 154 and 156. Molding press 110 remains open and curing press 112 remains closed.

[0046] As depicted by arrows B in FIGS. 11 and 12, first upper platen assembly 122 is lowered along vertical direction V towards lower platen assembly 116. This action forces the first strip of rubber material 94s against the first plurality of mold assemblies 114p. At the same time, upstream end 166 and downstream end 168 (FIG. 10) of the first strip of rubber material 94s are forced against first and second blade assemblies 154 and 156, respectively. This action cuts upstream end 166 and downstream end 168 such that a now shorter, the first strip of rubber material 94s fits between blade assemblies 154 and 156 as shown. As first upper platen assembly 122
continues to press the first strip of rubber material 94s, tread features are imparted or molded into first strip of rubber material 94s from the mold surfaces 142 of the first plurality of mold assemblies 114pp. Rubber material cut away from the first strip of rubber material 94s can be e.g., recycled back to extruder 102.

[0047] In one exemplary embodiment, the temperature of rubber strip 94s while in molding press 110 is within 5 degrees Celsius or less of the temperature of rubber strip 94 when it exits extruder 102. For example, rubber strip 94 and strip 94s may be within a temperature range of 90 degrees Celsius to about 100 degrees Celsius. Other temperatures may be used as well. In one exemplary aspect, the present invention can advantageously avoid reheating continuous rubber strip 94 and rubber strip 94s because such are molded shortly after extrusion in order to minimize heat loss.

[0048] Several steps are now undertaken to prepare for advancing the first strip of rubber 94s, and the first plurality of mold assemblies 114sp in process direction F towards the second strip of rubber material 98 supported on the second plurality of mold assemblies 114sp. Referring to FIGS. 13 and 14, as depicted by arrows C, first upper platen assembly 124 is raised along vertical direction V away from lower platen assembly 116. Additionally, second upper platen assembly 124 is also raised along vertical direction V away from lower platen assembly 116 - thereby removing pressure from the continuous rubber strip 98 on the second plurality of molding assemblies 114sp.

[0049] As can be determined by comparing e.g., FIGS. 13 and 14 with FIGS. 15 and 16, second blade assembly 156 is movable between a first and second position. In the first position (FIGS. 13 and 14), second blade assembly 156 is in contact with the downstream end 152 of the first plurality of mold assemblies 114pp and is between first upper platen assembly 122 and lower platen assembly 116. In the second position (FIGS. 15 and 16), second blade assembly is retracted from contact with the downstream end 152 of the first plurality of mold assemblies 114sp and is not between platen assemblies 116 and 122.

[0050] Similarly, third blade assembly 158 is movable between a first position and a second position. In the first position (FIGS. 13 and 14), third blade assembly 158 is in contact with the upstream end 150 of the second plurality of mold
assemblies 114_sp and is between second upper platen assembly 124 and lower plate assembly 116. In the second position, third blade assembly 158 is retracted from contact with the upstream end 150 of the second plurality of mold assemblies 114_sp and is no longer between second upper platen assembly 124 and lower plate assembly 116.

[0051] Accordingly, as shown in FIGS. 15 and 16, second blade assembly 156 and third blade assembly 158 have each been retracted to their respective second positions. Referring now to FIGS. 17 and 18, such retraction allows for the advancement of the first plurality of mold assemblies 114_fp towards the second plurality of mold assemblies 114_sp on curing press 112 as depicted by arrow D. This movement joins the downstream end 164 of the first strip of rubber material 94s with the upstream end 160 of the continuous strip of rubber material 98 - thereby increasing its overall length. Notably, first blade assembly 154 remains in contact with the upstream end 162 of the first strip of rubber material 94s during this movement.

[0052] Using mold assembly transport mechanism 104, the advancement of the first plurality of molds assemblies 114_fp continues until such are positioned under the second upper platen assembly 124 as depicted in FIGS. 19 and 20. Again, first blade assembly 154 remains in contact with the upstream end 162 of the first strip of rubber material 94s and the first mold assembly 114_fp during this movement as depicted by arrow H. The second plurality of mold assemblies 114_sp are simultaneously advanced further down curing press 112 along conveying direction F.

[0053] Next, as depicted in FIGS. 21 and 22 by arrow G, first blade assembly 154 is retracted along longitudinal direction L by moving in a direction opposite to flow direction F. This removes first blade assembly 154 from contact with the upstream end 150 of the first plurality of mold assemblies 114_fp and the upstream end 162 of the first strip of rubber material 94s (which is now joined with, and forms part of, rubber strip 98).

[0054] Thus, for this exemplary embodiment, first blade assembly 154 is selectively movable among at least three positions. In the first position, (FIGS. 7, 9, 11, 13, and 15), first blade assembly 154 is in contact with the upstream end 150 of
the first plurality of mold assemblies 114p and is between first upper platen assembly 122 and lower platen assembly 116. In the second position (FIG. 21), first blade assembly 154 is retracted from the upstream end 150 of the first plurality of mold assemblies 114p and is upstream of the first upper platen assembly 122 and lower platen assembly 116. In the third position (FIG. 19), first blade assembly 154 is in contact with the upstream end 150 of the first plurality of mold assemblies 114p and is between the second upper platen assembly 124 and the lower platen assembly 116. [0055] Referring again to FIGS. 21 and 22, as depicted by arrow M, third blade assembly 158 is placed back into its first position where it now makes contact with the upstream end 150 of the first plurality of mold assemblies 114p and the upstream end 162 of the rubber material now forming strip 98. [0056] As illustrated in FIGS. 23 and 24, second upper platen assembly 124 is now lowered (arrow Q) along vertical direction V onto the first plurality of mold assemblies 114p as well as the second plurality of molds assemblies 114p positioned further downstream thereof (not shown). This action presses the rubber materials now combined as rubber strip 98. Curing press 112 continues to apply heat and pressure to partially or fully cure rubber strip 98 as it passes therethrough. In one exemplary embodiment, the temperature of rubber strip 98 is heated to a temperature in the range of about 150 degrees Celsius to about 160 degrees Celsius for curing. Other temperatures may be used as well. [0057] While second upper platen assembly 124 presses both the first plurality of mold assemblies 114p as well as the second plurality of molds assemblies 114p, third blade assembly 158 is positioned against the first mold assembly 114p and upstream end 162 of the first strip of rubber material 94s, which is now part of rubber strip 98 as previously stated. As such, third blade assembly 158 helps prevent backflow of rubber material that might occur from the pressing by second upper platen assembly 124. [0058] The overall process can now be repeated again as described beginning with FIG. 5 by adding another strip of rubber material 94s so as to continue adding to the length of the continuous, elongated strip of rubber material 98.
In alternative aspect of the present invention, first blade assembly 154 can be used to prevent backflow of rubber material while pressing with second upper platen assembly 124. More particularly, instead of retracting first blade assembly 154 from its third position as depicted by arrow G in FIG. 21, first blade assembly 154 can remain in the third position depicted in FIG. 19 while the second upper platen assembly 124 is lowered against the first plurality of mold assemblies 114pp as well as the second plurality of molds assemblies 114sp. First blade assembly 154 can be retracted after such pressing and curing by the second upper platen assembly 124.

After mold assemblies 114 are moved through molding press 110 and curing press 112, cured rubber strip 98 with its now molded tread features must be demolded from mold assemblies 114 as such areadvanced along conveying direction F. As shown in FIGS. 2 and 3, near outfeed end 118, rubber strip 98 is pulled away from mold assemblies 114, passes around roller 132, and exits apparatus 100. Anti-stick fabric 136 may remain attached to rubber strip 98 or may be removed therefrom. After exiting outfeed end 118, rubber strip 98 can now be e.g., cut into desired size for storage and/or placement onto a tire carcass or stored for later processing.

Referring to FIGS. 1 and 3, apparatus 100 includes a mold assembly return mechanism 200 for returning mold assemblies 114 from outfeed end 118 of apparatus 100 to infeed end 106 of apparatus 100. After demolding from rubber strip 98, mold assemblies 114 are transferred laterally along transverse direction T from mold assembly transport mechanism 104 to mold assembly return mechanism 200. Mold assemblies 114 are then moved, as indicated by arrow R, in a direction opposite to conveying direction F. Near infeed end 106, mold assemblies 114 can be transferred along transverse direction T from mold assembly return mechanism 200 back to mold assembly transport mechanism 104. As such, mold assemblies 114 are circulated along a loop to provide a continuous supply for molding and translating rubber strip 98 along conveying direction F.

As will be understood using the teachings disclosed herein, a variety of mechanisms can be used to move mold assemblies 114 along return mechanism 200. By way of example, mold assembly return mechanism 200 may have a construction
similar to mechanism 104 such as e.g., a motorized conveyor system, rails, and/or a plurality of rollers with one or more devices for transporting mold assemblies 114 along mechanism 200 in the direction of arrow R. Other constructions may be used as well. Additionally, return mechanism 200 may include one or more heating devices for heating mold units 114 as such travel back to infeed end 106 on mechanism 200. Mold assembly return mechanism 200 could also be equipped with a mold cleaning device - removing rubber flashing and/or venting from the mold assemblies 114.

[0063] While the present subject matter has been described in detail with respect to specific exemplary embodiments and methods thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, the scope of the present disclosure is by way of example rather than by way of limitation, and the subject disclosure does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art using the teachings disclosed herein.
WHAT IS CLAIMED IS:

1. A method for continuous molding and curing of tire tread using movable mold assemblies arranged adjacent to each other along a conveying direction, the method comprising:
   - positioning a first strip of rubber material onto a first plurality of mold assemblies located between a plurality of blade assemblies, the first strip of rubber material including an upstream end and a downstream end;
   - forcing the first strip of rubber material against the first plurality of mold assemblies and one or more of the plurality of blade assemblies;
   - cutting the upstream end, the downstream end, or both, from the strip of rubber material;
   - advancing the first plurality of mold assemblies and the first strip of rubber material along the conveying direction;
   - joining the downstream end of the first strip of rubber material with an upstream end of a second strip of rubber material; and
   - pressing the first and second strips of rubber material.

2. The method for continuous molding and curing of tire tread as in claim 1, further comprising heating the first and second strips of rubber material during the pressing.

3. The method for continuous molding and curing of tire tread as in claim 1, further comprising curing the first and second strips of rubber material during the heating.

4. The method for continuous molding and curing of tire tread as in claim 1, wherein the forcing imparts tread features into the first strip of rubber material.
5. The method for continuous molding and curing of tire tread as in claim 1, wherein the forcing comprises lowering a first upper platen assembly against the first strip of rubber material and the first plurality of mold assemblies.

6. The method for continuous molding and curing of tire tread as in claim 1, wherein the pressing comprises lowering a second upper platen assembly against the first strip of rubber material carried on the first plurality of mold assemblies and the second strip of rubber material carried on a second plurality of mold assemblies positioned downstream of the first plurality of mold assemblies.

7. The method for continuous molding and curing of tire tread as in claim 1, further comprising
   extruding a continuous, elongated strip of rubber material; and
   cutting the first strip of rubber material from the continuous, elongated strip of rubber material.

8. The method for continuous molding and curing of tire tread as in claim 1, wherein the plurality of blade assemblies comprises a first blade assembly and a second blade assembly positioned downstream of the first blade assembly, and wherein the cutting comprises:
   cutting the upstream end of the first strip of rubber material with the first blade assembly; and
   cutting the downstream end of the second strip of rubber material with the second blade assembly.

9. The method for continuous molding and curing of tire tread as in claim 8, further comprising maintaining contact between the upstream end of the first strip of rubber material and the first blade assembly during the joining.

10. The method for continuous molding and curing of tire tread as in claim 9, further comprising maintaining contact between the upstream end of the first strip
of rubber material and the first blade assembly during the pressing to prevent a backflow of rubber material during the pressing.

11. The method for continuous molding and curing of tire tread as in claim 10, removing the first blade assembly from the upstream end of the first strip of rubber material after the pressing.

12. The method for continuous molding and curing of tire tread as in claim 9, wherein the plurality of blade assemblies further comprises a third blade assembly, the method further comprising positioning the third blade assembly against the upstream end of the first strip of rubber material to prevent a backflow of rubber material during the pressing.

13. The method for continuous molding and curing of tire tread as in claim 12, removing the third blade assembly from the upstream end of the first strip of rubber material after the pressing.

14. The method for continuous molding and curing of tire tread as in claim 1, further comprising applying an anti-stick fabric onto the first strip of rubber material before the pressing.

15. An apparatus for the continuous molding and curing of tire tread, the apparatus defining a longitudinal axis, the apparatus comprising:
mold assemblies movable along the longitudinal axis, each mold assembly have an upstream end and a downstream end;
a mold assembly transport mechanism arranged along the longitudinal axis and configured for moving mold assemblies along a conveying direction, the mold assembly transport mechanism having an in-feed end and an out-feed end;
a lower platen assembly extending along the longitudinal axis;
a first upper platen assembly positioned near the infeed end of the mold assembly transport mechanism, the first upper platen assembly selectively movable along a vertical direction relative to the lower platen assembly;

a second upper platen assembly positioned adjacent and downstream of the first lower platen assembly, the second upper platen assembly selectively movable along the vertical direction relative to the lower platen assembly;

a first blade assembly selectively movable between i) a first position in contact with the upstream end of a first plurality of the mold assemblies and below the first upper platen assembly and ii) a second position retracted from contact with the upstream end of the first plurality of mold assemblies;

a second blade assembly movable among i) a first position in contact with the downstream end of the first plurality of mold assemblies and below the second upper platen assembly and ii) a second position retracted from contact with the downstream end of the first plurality of mold assemblies; and

a third blade assembly movable among i) a first position in contact with the upstream end of a second plurality of the mold assemblies and below the second upper platen assembly and ii) a second position retracted from contact with the upstream end of the second plurality of mold assemblies.

16. The apparatus for the continuous molding and curing of tire tread as in claim 15, wherein the first blade assembly is also selectively movable among iii) a third position in contact with the upstream end of the first plurality of mold assemblies and below the second upper platen.

17. The apparatus for the continuous molding and curing of tire tread as in claim 15, further comprising one or more motors for moving the first and second upper platen assemblies along the vertical direction.

18. The apparatus for the continuous molding and curing of tire tread as in claim 15, further comprising an extruder positioned upstream from the mold assembly
transport mechanism and configured for extruding a strip of rubber material for positioning over the lower platen assembly.
INTERNATIONAL SEARCH REPORT

PCT/US2015/032911

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B29D 30/06 (2015.01)
CPC - B29D 30/06 (2015.04)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B29C 35/00; B29D 30/06, 30/58 (2015.01)
USPC - 156/405.1, 425/46, 425/451

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC -B29C 35/00; B29D 30/06, 30/58 (2015.04) (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar, Google
Search terms used: tire tread continuous mold curing blade assembly upstream downstream

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 3,827,846 A (WEILER et al) 06 August 1974 (06.08.1974) entire document</td>
<td>1-18</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.
See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search
27 July 2015

Date of mailing of the international search report
14 AUG 2015

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Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Authorized officer
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