

METHOD OF AND APPARATUS FOR CONTINUOUSLY MANUFACTURING
SLIDE FASTENER COUPLING ELEMENTS

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The present invention relates to a method of and an apparatus for continuously manufacturing molded slide fastener coupling elements of thermoplastic synthetic resin.

5 Continuous coupling elements for slide fasteners have found widespread use since they are available in a variety of shapes and colors, have coupling heads of an ideal configuration, render a resultant slide fastener mechanically strong, are relatively light, and can be
10 manufactured at a high rate of production and hence inexpensively. Such molded coupling elements are produced by first molding a strip of coupling element blanks, and then folding the blank strip about its longitudinal axis into a U-shape while being heated by
15 high-frequency heating, which may be followed by ultrasonic bonding of legs of formed coupling elements. When these two processing steps are combined together, the overall rate of production of coupling elements becomes reduced since the step of high-frequency heating
20 or ultrasonic bonding takes much more time than the step of molding the strip of coupling element blanks. To cope with this difficulty, it has been proposed to carry out these two steps independently on separate apparatus such as disclosed in U.S. Patents Nos. 4,025,277
25 patented May 24, 1977 and 4,210,985 patented July 8, 1980. The former U.S. patent discloses an apparatus for



folding and fusing a strip of coupling element blanks, the apparatus including heater for heating the strip of coupling element blank which has been cooled down after being discharged from a molding apparatus as disclosed in the latter U.S. Patent. The proposed process is also disadvantageous in that an additional time is required to heat the blank strip again for folding and heat-setting or bonding the latter, resulting in a reduction in the rate of manufacture of molded slide fastener coupling elements.

According to one aspect of the present invention there is provided a method of continuously manufacturing molded slide fastener coupling elements, comprising the steps of:

- 15 (a) introducing thermoplastic synthetic resin successively into cavities around a circumferential surface of a die wheel while the latter is rotating, to mold a strip of coupling element blanks;
- (b) removing said strip of coupling element blanks continuously out of said cavities;
- 20 (c) folding said strip of coupling element blanks about its longitudinal axis into a U-shape while heating it to provide coupling heads and legs on each side thereof;
- 25 (d) further heating the folded coupling element blanks and shaping them into slide fastener coupling elements of a finalized shape while being continuously fed along; and

(15) (e) discharging said slide fastener coupling elements continuously at a speed which is substantially the same as speed at which the strip of coupling element blanks is molded continuously on said die wheel.

5 According to another aspect of the invention there is provided an apparatus for continuously manufacturing slide fastener coupling elements comprising:

(a) a frame;

10 (b) a die wheel mounted on said frame for continuous rotation at a peripheral speed and having on and around a circumferential surface thereof a plurality of die cavities for molding a strip of coupling element blanks having central coupling heads and legs on each side thereof;

15 (c) an extruder nozzle mounted on said frame and directed toward said circumferential surface of the die wheel for injecting thermoplastic synthetic resin succesively into said die cavities;

20 (d) a folder unit mounted on said frame for folding said strip of coupling element blanks about its longitudinal axis as the strip is continuously withdrawn from said die wheel, said folder unit including a primary heater for heating said strip while being folded;

25 (e) a secondary heater unit mounted on said frame for further heating said folded strip of coupling element blanks;

(f) an element-forming die mounted on said frame for shaping said folded strip of coupling element blanks

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further heated by the secondary heater, into slide fastener coupling elements;

(g) a cooling unit mounted on said frame for cooling said coupling elements; and

5 (h) a discharging unit located adjacent to said cooling unit for discharging said coupling elements at a speed which is substantially the same as said peripheral speed of said die wheel.

The invention will be described by way of examples with reference to the accompanying drawings, wherein:-

10 FIG. 1 is a fragmentary plan view of a strip of coupling element blanks;

FIG. 2 is a side elevational view, partly in cross section, of the strip of coupling element blanks shown in FIG. 1;

FIG. 3 is a fragmentary plan view of the strip of coupling element blanks of FIG. 1 as it is folded about its longitudinal axis into a strip of coupling elements of a U-shaped cross section;

20 FIG. 4 is a cross-sectional view taken along line IV - IV of FIG. 3;

FIG. 5 is an enlarged plan view of a slide fastener stringer including the coupling elements of FIG. 3 sewn in place on a stringer tape;

25 FIG. 6 is a cross-sectional view taken along line VI - VI of FIG. 5;

FIG. 7 is a cross-sectional view of another slide fastener stringer;

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FIGS. 8 and 9 are fragmentary plan views of different coupling element blanks;

FIG. 10 is a schematic front elevational view of an apparatus in accordance with the present invention;

5 FIG. 11 is an enlarged fragmentary plan view of a circumferential surface of an extruder die wheel;

FIG. 12 is a fragmentary enlarged cross-sectional view of the die wheel shown in FIG. 11 and an extruder nozzle;

10 FIG. 13 is a fragmentary cross-sectional view of a folder die wheel;

FIG. 14 is an enlarged fragmentary cross-sectional view taken along line XIV - XIV of FIG. 10;

15 FIG. 15 is an enlarged view of a portion of the folder die wheel shown in FIG. 14;

FIG. 16 is an enlarged plan view of a hot-air blower nozzle;

FIG. 17 is an enlarged side elevational view, with parts cut away, of a modified secondary heater unit;

20 FIG. 18 is a cross-sectional view taken along line XVIII - XVIII of FIG. 17;

FIG. 19 is an enlarged cross-sectional view taken along line XIV - XIV of FIG. 10;

25 FIG. 20 is an enlarged cross-sectional view taken along line XX - XX of FIG. 10; and

FIG. 21 is an enlarged cross-sectional view of a bonding unit.

Molded slide fastener coupling elements of

thermoplastic synthetic resin to be produced according to a method and an apparatus in accordance with the present invention will first be described with reference to FIGS. 1 to 9. In FIG. 1, a molded strip of coupling element blanks 10 is in a zig zag or meandering form and comprises a plurality of parallel element-forming bars 10a each including a central coupling head 11 and a pair of legs 12, 13 extending from the coupling head 11 in opposite directions, the element-forming bars 10a being connected to each other by connecting portions 14, 15 integral with the legs 12, 13 at their distal ends. As shown in FIG. 2, the strip of coupling element blanks 10 is folded in the directions of the arrows A, B about its longitudinal axis to form the coupling heads 11 into a U-shape, and the folded blank strip 10 is stabilised or set with a combination of heating and cooling to form a train of slide fastener coupling elements 16 as shown in FIGS. 3 and 4. Each of the coupling elements 16 has a pair of parallel legs 17, 18 corresponding to the legs 12, 13 of the coupling element blank 10. The coupling elements 16 are attached to a slide fastener stringer tape 19 (FIGS. 5 and 6) by sewing threads 20 with the legs 17, 18 disposed one on each side of the stringer tape 19. As illustrated in FIG. 7, the coupling elements 23 may have their legs 17, 18 bonded to each other at respective confronting surfaces 21, 22 (FIG. 4) thereof, and the coupling elements 23 may be sewn to, or woven or knitted into a slide fastener stringer tape 24

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in a manner well known in the art.

FIG. 8 shows another molded strip of coupling element blanks 25 which includes a pair of connector threads 26, 27 embedded in connecting portions 28, 29 at the time of molding the strip of coupling element blanks 25. With the connector threads 26, 27, element-forming bars 25a are securely connected to each other, and the strip of coupling element blanks 25 is rendered resistant to forces applied in the directions of the arrow C which tends to stretch the strip of coupling element blanks 25 longitudinally. According to a modification of FIG. 9, a molded strip of coupling element blanks 30 comprises a plurality of separate parallel element-forming bars 33 which are interconnected at their ends by a pair of connector threads 31, 32. The strips of coupling element blanks 25, 30 are also folded into a U-shape and stabilised or set in their final shape as slide fastener coupling elements. The connector threads 26, 27 and 31, 32 may be removed later by dissolving them in a solution, or may be left so that they can be woven or knitted into a slide fastener stringer tape to attach the coupling elements to the stringer tape.

FIG. 10 illustrates an apparatus generally designated at 35 for continuously molding such a strip of coupling element blanks and forming the blank strip into a train of molded coupling elements of a finalized shape. The apparatus 35 comprises a frame 36 on which

there is mounted a die wheel 37 for continuous rotation in the direction of the arrow D. The die wheel 37 has on and around its circumferential surface 38 (FIGS. 11 and 12) a plurality of parallel die cavities 40 for molding, for example, element-forming bars 10a and a plurality of alternate die cavities 42 extending between the ends of the die cavities 40 for molding, for example, connecting portions 14, 15. A shoe 43 is held against the circumferential surface 28 of the die wheel 37 and has an extruder nozzle 44 (FIG. 12) for introducing molten thermoplastic synthetic resin successively into the die cavities 40 and hence the die cavities 42 as the die wheel 37 rotates. While the die wheel 37 revolves in the direction of the arrow D, the molten thermoplastic is solidified in the die cavities 40, 42 to form a molded strip of coupling element blanks 10 which is separated from the die wheel 37 at a point E and fed around guide rolls 46, 47, 48. The rate of feed of the strip of coupling element blanks 10 is such that the latter will be separated from the die wheel 22 without being subjected to any substantial tension since the blank strip 10 as it leaves the die wheel 22 retains heat intensive enough to allow the strip 10 to be easily deformed.

The apparatus 35 also includes a folder unit 49 mounted on the frame 36 adjacent to the die wheel 37 and comprising a folder die wheel 50 mounted on the frame 36 for driven rotation in the direction of the arrow F and



having a primary heater including heater elements 52 and a peripheral groove 53, and a folder disc 51 mounted on the frame 36 for driven rotation in the direction of the arrow G and having a peripheral edge 54 disposed partly

5 in the peripheral groove 53 in the folder die wheel 50. The molded strip of coupling element blanks 10 is introduced between the folder die wheel 50 and the folder disc 51 as they are driven to rotate, whereupon the blank strip 10 is forced by the peripheral edge 54

10 of the holder disc 51 into the peripheral groove 53 in the folder die wheel 50 so as to be folded about its longitudinal axis into a U-shape. The blank strip 10 can be folded easily since it is sufficiently pliable due to heat retained in the strip 10 after having been

15 molded and additional heat applied by the primary heater elements 52 in the folder die wheel 50. For effective utilization of the heat retained in the blank strip 10, the holder unit 49 should preferably be located as closely to the die wheel 37 as possible.

20 The folded strip of coupling element blanks 10 is supplied with a core cord 56 fed through a guide 55 when the blank strip 10 is about to leave the folder die wheel 50 at point H, the core cord 56 being made of heat-resistant yarn such as cotton yarn. As best shown

25 in FIG. 13, the core cord 56 is fed tangentially to the folder die wheel 50 where the core cord 56 is interested between the legs 12, 13 against inner surfaces 57 of the heads 11 of the blank strip 10.

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The folded strip of coupling element blanks 10 as it is discharged from the folder unit 49 travels around a guide roller 58 and enters a secondary heater unit 60 mounted on a horizontal frame extension 59 secured to the frame 36. The secondary heater unit 60, as best shown in FIGS. 14 and 15, sets or stabilises the blank strip 10 with a combination of heating and cooling. It comprises a guide 61 having a downwardly opening slot 63 of a trapezoidal cross section and a hot-air blower 62 disposed below the guide 61, the guide 61 and the hot-air blower 62 being coextensive in length as shown in FIG. 10. The guide 61 contains therein heaters 64 and a passage 65 for a coolant such as water. The folded blank strip 10 slidably fits in the slot 63 as it travels therethrough with the legs 12, 13 directed divergently downwardly. The guide 61 is controlled by the heaters 64 and water passage 65 to be maintained at a temperature of about 50°C. The hot-air blower 62 has an oblong opening 66 held in registration and communication with the slot 63 and a stainless-steel mandrel 67 of a triangular cross section extending longitudinally through and centrally of the opening 66 with one flat side of the mandrel 67 facing the slot 63. The hot-air blower 62 is maintained at a temperature of about 150°C by heaters 69. Hot air at a temperature ranging from 300 to 320°C is supplied from three pipes 68 below the hot-air blower 62 through the opening 66 into the slot 63 in the guide 61. The hot

air as it flows upwardly through the opening 66 is divided by the downwardly tapered mandrel 67 into two streams I and J (FIG. 15) which impinge mainly on the legs 12, 13, respectively, to heat the latter.

5 The core cord 56 is held against the surfaces 57 of the heads 11 and serves as a shield against the hot air streams to thereby prevent the heads 11 from becoming melted or deformed.

10 FIGS. 17 and 18 illustrate another embodiment in which a tube 70 extends longitudinally through the slot 63 for allowing a coolant such as water at a temperature of about 50°C to pass therethrough. The heads 11 of the blank strip 10 travelling through the slot 63 ride on a horizontal portion of the tube 70 and hence are
15 prevented from being excessively heated by the hot air blown upwardly into the slot 63.

The legs 12, 13 of the folded blanks strip 10 can be heated to a desired temperature while moving along through the slot 63 by adjusting the temperature of the
20 hot air supplied and/or selecting the length L of the secondary heater unit 60.

An element-forming die 71 is mounted on the frame extension 59 next to or downstream of the secondary heater unit 60. The element-forming die 71 includes, as
25 illustrated in FIGS. 19 and 20, an upper block 72 having a slot 73 and a lower block 74 disposed downwardly of the upper block 72 and closing the slot 73. The slot 73 has a progressively constricted cross section such that



its contour near the secondary heater unit 60 is substantially the same as of the slot 63 in the secondary heater unit 60 as shown in FIG. 19, but is of a substantially U-shape at a position remote from the secondary heater unit 60 as shown in FIG. 20. Thus, as the folded strip of coupling element blanks 10 rendered sufficiently pliable by being heated by the secondary heater unit 60 passes through the slot 73, the blank strip 10 is forced by the progressively constricted contour of the slot 73 to be squeezed into a train of slide fastener coupling elements 16 of a finalized U-shape, with legs 17, 18 thereof extending substantially parallel to each other (FIG. 20). At the same time, connecting portions 14, 15 of the coupling elements 16 are shaped as desired by the lower block 74.

The slide fastener coupling elements 16 thus molded and shaped pass through a cooling unit 75 (FIG. 10) where the coupling elements 16 are cooled, and then are fed out by a discharging unit 76 which is driven as by a torque motor (not shown) such that the coupling elements 16 are discharged at a speed which is substantially the same as the speed at which the strip of coupling element blank 10 is molded, or the peripheral speed of the die wheel 37. The strip of coupling element blanks 10 as it is processed into the coupling elements 16 is therefore caused to travel at the same rate as that of molding of the blank strip 10, with the results that the blanks strip 10 will not be subjected to undue tension and



hence deformation, and the coupling elements 16 can be manufactured at a high production rate commensurate with the speed at which the strip of coupling element blanks 10 is continuously molded.

5 A bonding unit 77 (FIG. 10) may be positioned between the element-forming die 71 and the cooling unit 75 for bonding together the legs 17, 18 of the coupling elements 23 as illustrated in FIG. 7. The bonding unit 77 comprises a pair of horizontal toothed wheels 78, 79 rotatable in a common plane on a pair of shafts 80, 81, respectively, for forcing the legs 17, 18 into contact with each other. When the legs 17, 18 are forced in contact with each other, they are bonded together as they are still soft due to the heat applied by the secondary heater unit 60. The coupling elements 23 thus squeezed by the toothed wheels 78, 79 are held for positional stabilization therebetween by a pair of upper and lower pressers or rollers 82, 83 disposed one on each side of the common plane of rotation of the toothed wheels 78, 79. One of the toothed wheels 79 is movable toward and away from the other toothed wheel 78 in the directions of the arrows K in FIG. 21 for adjusting the degree of bonding between the legs 17, 18.

25 The core cord 56 may be removed from the coupling elements 16 by a roller 84 (FIG. 10) and supplied again to the folder die wheel 50, the core cord 56 being endless for such reuse. Where the molded strip of coupling element blanks 25 (FIG. 8) is to be formed into

coupling elements, the connector threads 26, 27 may be removed by the roller 84. To facilitate removal of the connector threads 26, 27, the connector threads 26, 27 should preferably be embedded partly in connecting portions 28, 29 so as to be easily detachable.

Where the coupling elements 23 shown in FIG. 7 are to be manufactured, the core cord 56 may remain inserted between the bonded legs 17, 18 instead of being removed by the roller 54.

The connecting threads 26, 27 and 30, 31, where incorporated, are supplied between the die wheel 27 and the shoe 43, as shown in FIG. 10. Inclusion of the connecting threads 26, 27 and 30, 31 enables the blanks strips 25, 30 to be tensioned longitudinally without being deformed.

When molten thermoplastic synthetic resin is introduced from the extruder nozzle 44 successively into the die cavities 40 around the die wheel 37 to mold a strip of coupling element blanks, the die wheel 37 is heated up to a temperature ranging from about 120 to 130°C. The molded strip of coupling element blanks as it leaves the die wheel 37 retains heat and, before losing such retained heat, is additionally heated by the heaters 52, whereupon the blank strip is folded by the folder unit 49 into a U-shape. The folded blank strip is heated again by the secondary heater unit 60 and is shaped into a train of slide fastener coupling elements as they are heat-set. Accordingly, the heat retained by



the molded strip of coupling element blanks is utilized effectively for subsequent processing steps of forming coupling elemnts.

Claims:-

1. A method of continuously manufacturing molded slide fastener coupling elements, comprising the steps of:

5 (a) introducing thermoplastic synthetic resin successively into cavities around a circumferential surface of a die wheel while the latter is rotating, to mold a strip of coupling element blanks;

(b) removing said strip of coupling element blanks continuously out of said cavities;

10 (c) folding said strip of coupling element blanks about its longitudinal axis into a U-shape while heating it to provide coupling heads and legs on each side thereof;

15 (d) further heating the folded coupling blanks and shaping them into slide fastener coupling elements of a finalized shape while being continuously fed along; and

20 (e) discharging said slide fastener coupling elements continuously at a speed which is substantially the same as the speed at which the strip of coupling element blanks is molded continuously on said die wheel.

2. A method according to Claim 1, said slide fastener coupling elements being further heated in step (d) by being heated with hot air .

25 3. A method according to Claim 1 or 2 wherein, prior to the further heating of step (d), there is the step of introducing a cord longitudinally through the



strip of folded coupling element blanks so as to be held against said coupling heads between said legs.

4. A method according to Claim 3, including the step of removing said cord out of said coupling elements substantially simultaneously with said discharging step.

5. A method according to any preceding claim including the step of bonding said legs together subsequent to said heat-setting step.

6. An apparatus for continuously manufacturing slide fastener coupling elements, comprising:

(a) a frame;

(b) a die wheel mounted on said frame for continuous rotation at a peripheral speed and having on and around a circumferential surface thereof a plurality of die cavities for molding a strip of coupling element blanks having central coupling heads and legs on each side thereof;

(c) an extruder nozzle mounted on said frame and directed toward said circumferential surface of the die wheel for injecting thermoplastic synthetic resin successively into said die cavities.

(d) a folder unit mounted on said frame for folding said strip of coupling element blanks about its longitudinal axis as the strip is continuously withdrawn from said die wheel, said folder unit including a primary heater for heating said strip while being folded;

(e) a secondary heater unit mounted on said frame for further heating said folded strip of coupling



element blanks;

(f) an element-forming die mounted on said frame for shaping said folded strip of coupling element blanks, further heated by the secondary heater, into slide fastener coupling elements;

(g) a cooling unit mounted on said frame for cooling said coupling elements; and;

(h) a discharging unit located adjacent to said cooling unit for discharging said coupling elements at a speed which is substantially the same as said peripheral speed of said die wheel.

7. An apparatus according to Claim 6, on said folder unit comprising a folder die wheel rotatably mounted on said frame and having a peripheral groove, and a folder disc rotatably mounted on said frame and having a peripheral edge positioned in said peripheral groove for continuously forcing said strip of coupling element blanks longitudinally centrally into said peripheral groove.

8. An apparatus according to Claim 6, said secondary heater unit comprising a guide having a slot of a trapezoidal cross section for guiding said folded strip of coupling element blanks to pass therethrough, and means for heating said folded strip of coupling element blanks while the latter is moving through said slot.

9. An apparatus according to Claim 8, said element forming die being located contiguously to said guide.



10. An apparatus according to Claim 8, said secondary heater unit further comprising a tube extending through said slot for passage of a cooling medium therethrough to protect said coupling heads of the coupling element blanks against being excessively heated by said heating means.

11. An apparatus according to Claim 8, said element-forming die having a slot held in registration with said slot of said secondary heater and having a cross section which is progressively constricted for shaping said folded strip of coupling element blanks continuously into the slide fastener coupling elements.

12. An apparatus according to claim 8, said heating means comprising a hot-air blower for supplying hot air into said slot in said guide.

13. An apparatus according to Claim 6, including a bonding unit mounted on said frame adjacent to said element forming die for bonding said legs of the coupling elements as the latter are discharged out of said element-forming die.

14. An apparatus according to Claim 13, said bonding unit comprising a pair of toothed wheels rotatable in a common plane for jointly forcing therebetween said legs into contact with each other, and a pair of pressers disposed one on each side of said common plane for holding said coupling elements therebetween as the latter pass between said toothed wheels.