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(54) **DIVERTER VALVE**

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USPC **137/597**
See application file for complete search history.

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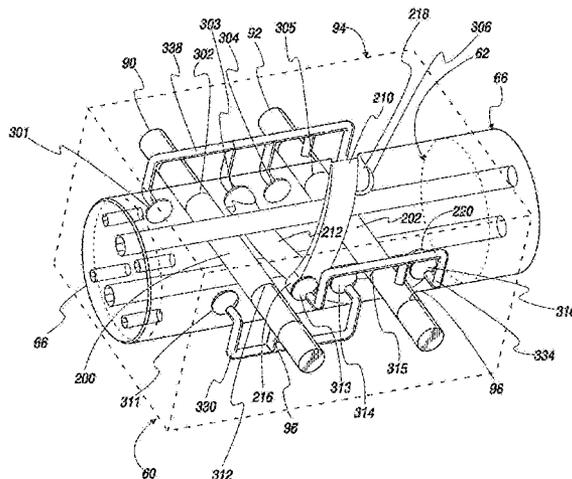
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(57) **ABSTRACT**

A diverter valve controlling input of two different extruded materials has a valve body having an axially extending opening, and a valve piston axially movable in the opening between first and second positions. The body defines a first inlet for receiving a first material, and a second inlet for receiving a second material with first and second outlets opposite the inlets. The piston has first and second through channels and first and second cross-over channels, each with inlet side and outlet side ports. A first flushing channel communicates with the first inlet and end ports, a second flushing channel communicates with the second inlet and end ports, and a third flushing channel opposite the first two communicates with the second outlet and includes a plurality of ports, with all the ports, inlets and outlets open to the axial opening.

17 Claims, 6 Drawing Sheets



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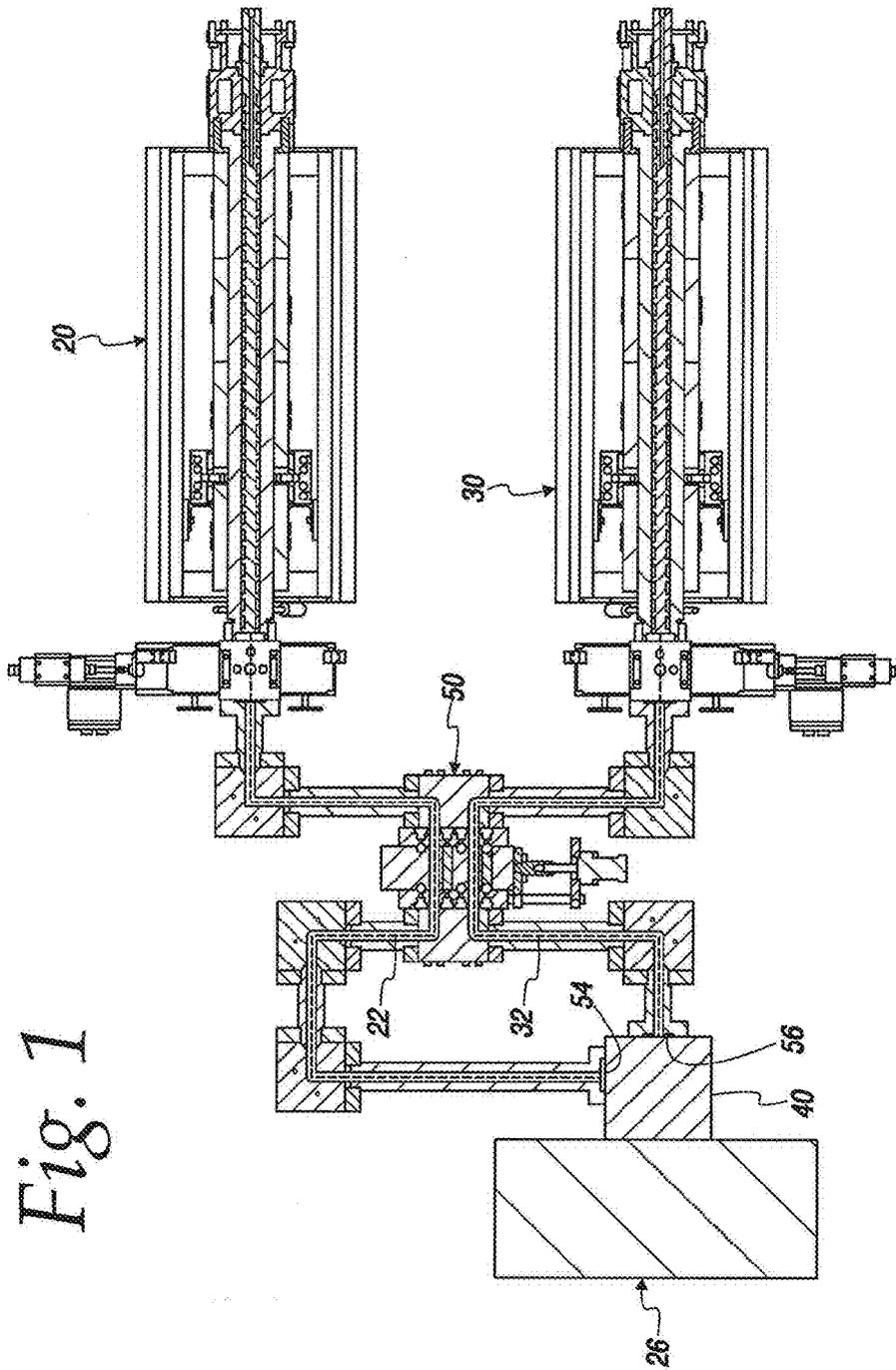


Fig. 1

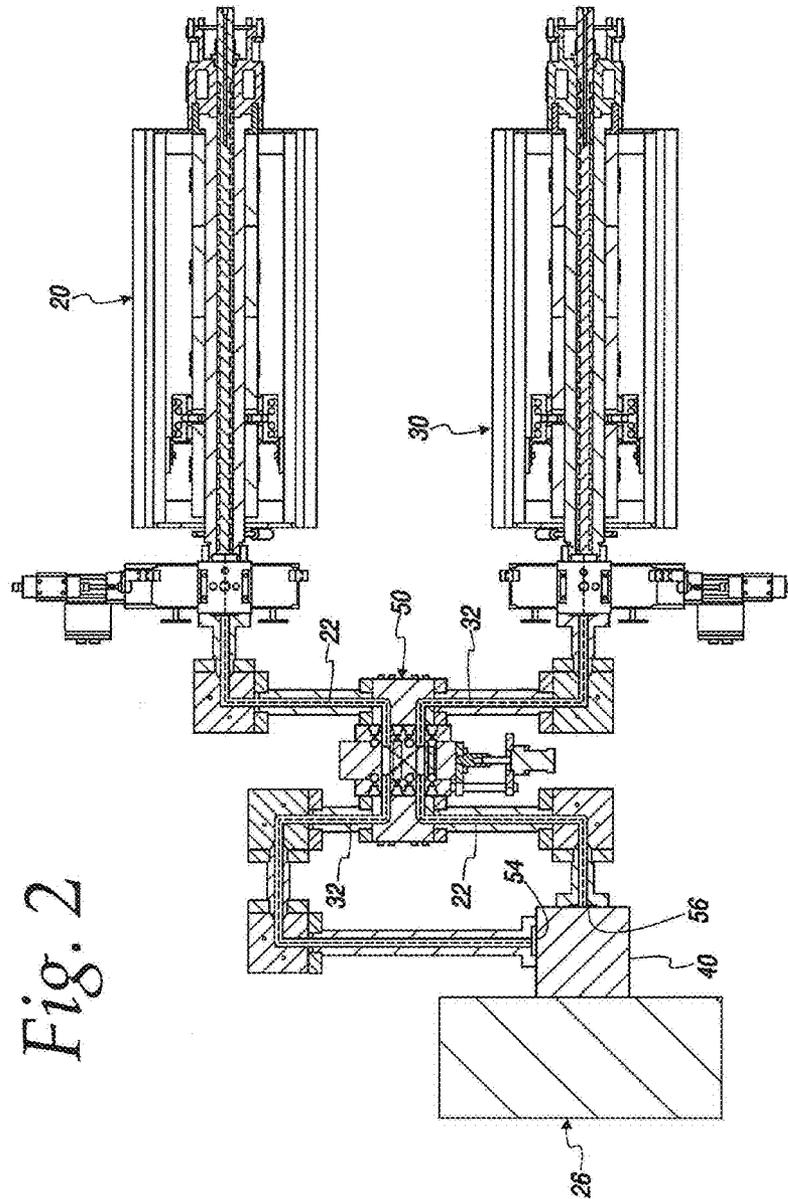


Fig. 2

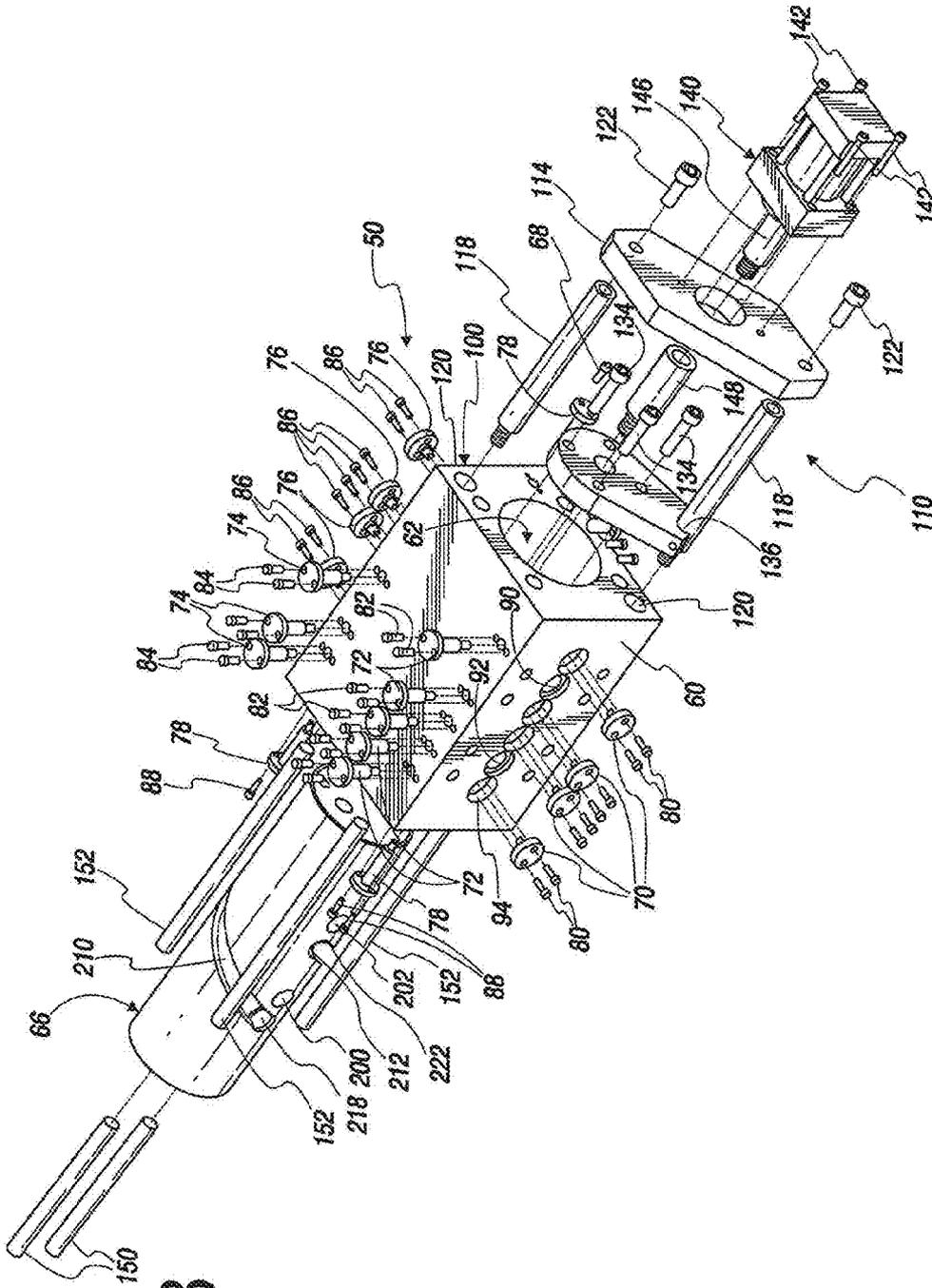


Fig. 3

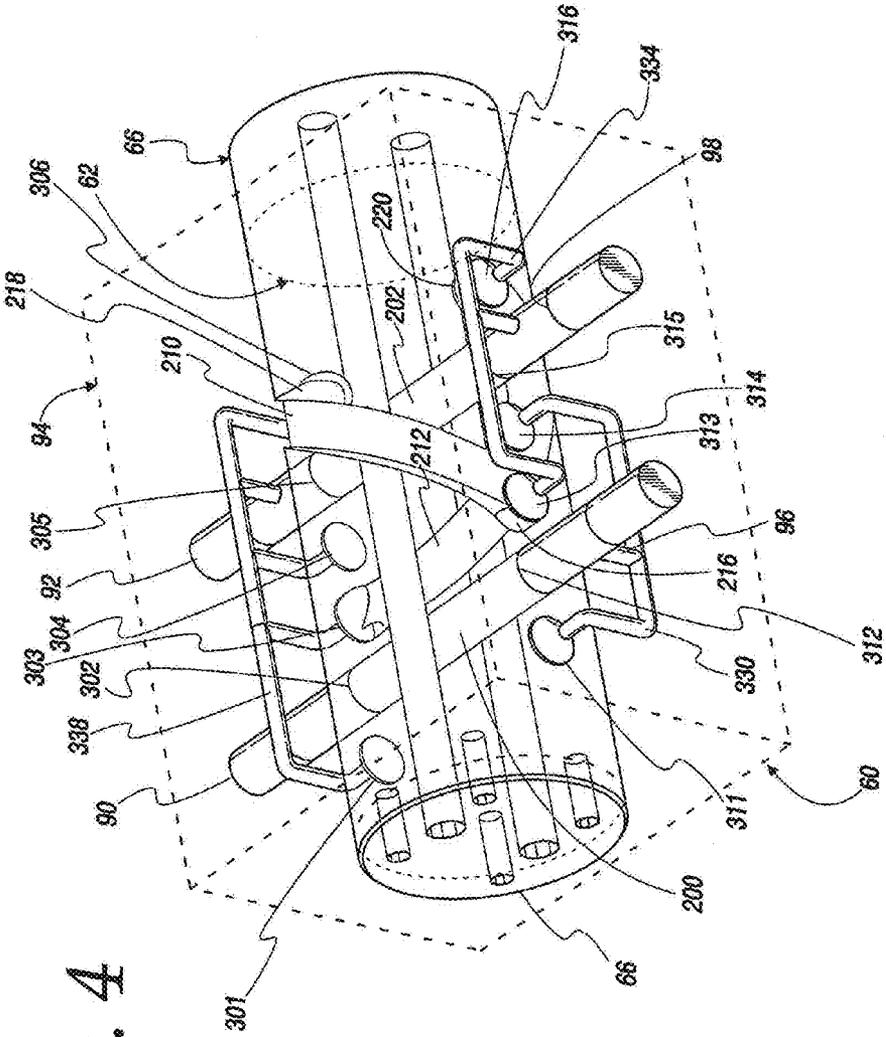


Fig. 4

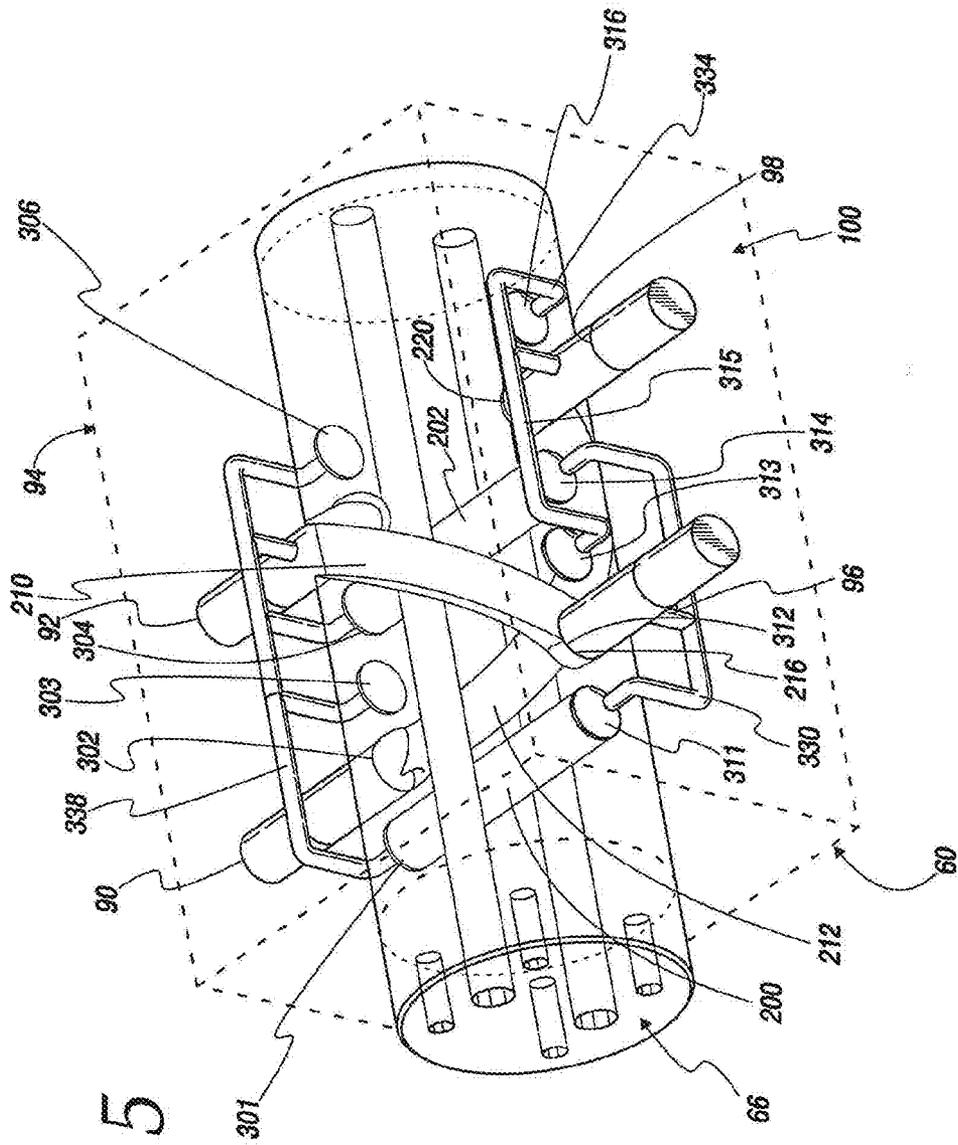


Fig. 5

Fig. 6

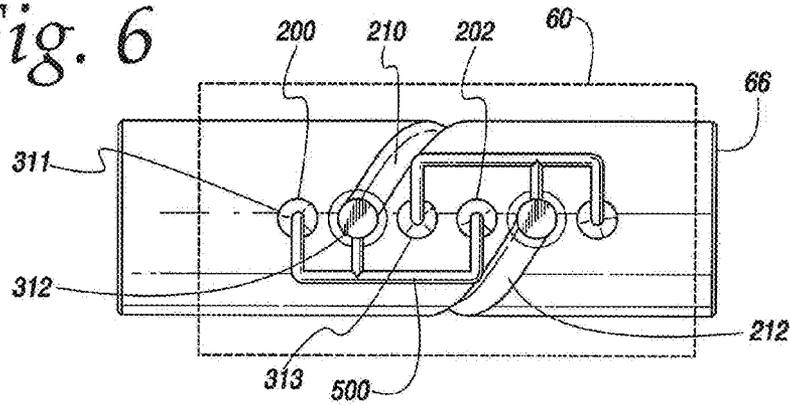


Fig. 7

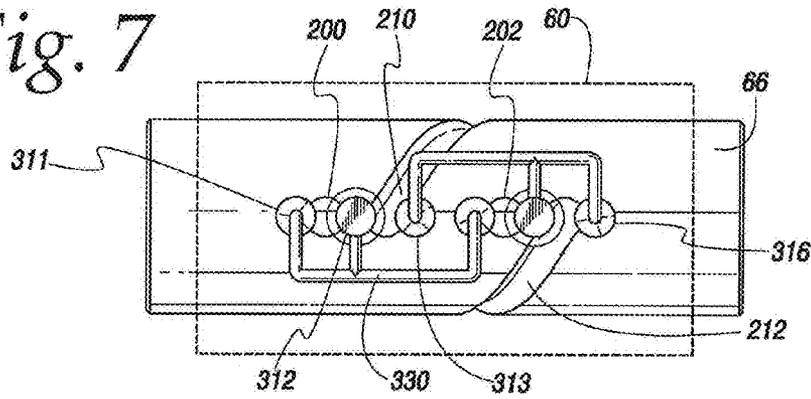
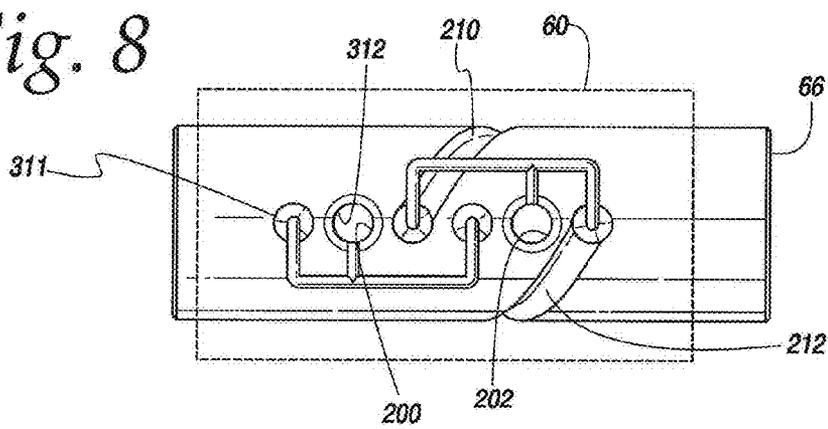


Fig. 8



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DIVERTER VALVE

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO RELATED
APPLICATION(S)

Not applicable.

STATEMENT REGARDING BACKGROUND OF
THE INVENTION AND TECHNICAL
PROBLEMS POSED BY THE PRIOR ART

Molding of extruded materials to form countless products is widely done. As is well known, an extruder is used to provide the extruded material to a suitable die in which the extruded material is shaped to create the desired object. Commonly, the object which is created has a uniform continuous shape, such as conduits, pipes and flat sheets.

Extruded sheets, for example, may be formed from many different materials, with many different thicknesses, and with different layer constructions. An extruded sheet may be formed by itself or combined with one or more other sheet layers that are concurrently formed, or combined after formation. In a typical apparatus for extrusion forming of sheet products, a roll stand is placed downstream of an extruder assembly with an associated sheet die. Flowable material is delivered from one or more extruders through the sheet die to a nip/lamination location between adjacent rolls on the roll stand.

Apparatuses for forming an extruded sheet products are Shown, for example, in my U.S. Ser. No. 12/455,353, entitled "Height Positioning Mechanism for Roll Stand Assembly on an Apparatus for Continuously Forming an Extruded Sheet Product", filed Jun. 1, 2009; U.S. Ser. No. 12/455,344, entitled "Linear Bearing Assembly to Guide Movement of Roll Stand on Apparatus for Forming an Extruded Sheet Product", filed Jun. 1, 2009; U.S. Ser. No. 12/455,376, entitled "Gap Adjusting Mechanism for Rolls on a Roll Stand Used in the Extrusion Forming of a Sheet Product", filed Jun. 1, 2009; and U.S. Published Patent Application No. US-2010-0038037-A1, entitled "Apparatus for Applying a Film to a Bottom Side of an Extruded Sheet", published Feb. 18, 2010. The disclosures of all of these patent applications is hereby fully incorporated by reference.

Moreover, various products, including sheet products, can require the use of two separate materials, such as shown, for example, in U.S. Publ. Application No. US-2008-0314525-A1, entitled "Web Lamination System", published Dec. 25, 2008, the disclosure of which is hereby fully incorporated by reference. Molding of such products requires the supply of material from at least a first extruder assembly and a second extruder assembly, with a first material provided by one and a second material provided by the other. It should be appreciated that use two different materials may from time to time be switched. For example, when the two materials differ in color, or in texture, it may be desirable to form a product (e.g., a sheet material) having one color or texture on its outer skin, and also to form a similar product but with the other color or texture on its outer skin. This may be accomplished by swap-

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ping the connection between the outputs of the extruder assemblies to the inputs of the mold.

It should be appreciated, however, that swapping connections can result in bleed over and mixing of materials in the lines between the extruder assemblies and the mold. If, for example, one of the materials is hidden on the interior of a sheet, covered by the other material on the skin of the sheet, such mixing of materials in the unseen interior of the sheet may not be a major concern. However, similar mixing of the material which is molded to form the skin of the sheet can cause the sheet to have a different visible color than desired, either through some mixing of the colors or a speckling of one color with the other. Such an appearance is not only not what is desired, but it can give the appearance that the sheet was poorly manufactured, and possibly make the sheet unacceptable to a buyer.

The present invention is directed toward overcoming one or more of the problems set forth above.

SUMMARY OF THE INVENTION

The present invention provides a novel, improved valve for diverting between two different extruded materials to swap the material sent to different parts of a mold block, where the purity of the material sent to one part of the mold block is critical to the manufacture of the molded material. This is accomplished with a compact structure which may be easily and reliably operated and controlled with minimal addition of parts.

In one aspect of the present invention, a diverter valve is provided for controlling input of two different extruded materials to a mold for molding one of the materials covering the other of the materials. The diverter valve includes a valve body having an axially extending opening therethrough, and a valve piston selectively axially movable in the body opening between a first position and a second position. The valve body defines (a) a first inlet in one side adapted to receive a first extruded material, and a second inlet in the one side adapted to receive a second extruded material, (b) a first outlet in the side opposite of the one side, and a second outlet in the opposite side, (c) a first flushing channel communicating with the first inlet and including end ports open to the axial opening, (d) a second flushing channel communicating with the second inlet and including end ports opening to the axial opening, and (e) a third flushing channel communicating with the second outlet and including a plurality of ports opening to the axial opening. The piston defines first and second through channels extending between the one side and the opposite side, a first cross-over channel having an inlet side port and an outlet side port, and a second cross-over channel having an inlet side port and an outlet side port. In the first piston position, (i) the first through channel connects the first inlet with the first outlet and the second through channel connects the second inlet with the second outlet, (ii) the valve piston blocks the end ports of the first flushing channel, and (iii) the first and second cross-over channels connect the second and third flushing channels to allow flow of material therein from the second inlet. In the second piston position, (i) the first cross-over channel connects the first inlet with the second outlet and the second cross-over channel connects the second inlet with the first outlet, (ii) the valve piston blocks the end ports of the first flushing channel, and (iii) the first and second through channels connect the first and third flushing channels to allow flow of material therein from the first inlet.

In one form of this aspect of the invention, flow of material from the flushing channels to the first outlet is blocked in both the first and second positions of the valve piston.

In another form of this aspect of the present invention, the first and second inlets are axially spaced a distance X, and the first and second outlets are axially spaced the distance X, the first and second through channels are axially spaced the distance X, the inlet side port of the first cross-over channel and the inlet side port of the second cross-over channel are axially spaced the distance X, and the outlet side port of the first cross-over channel and the outlet side port of the second cross-over channel are axially spaced the distance X. In a further form, the second cross-over channel inlet side port is axially aligned with the first cross-over channel outlet side port and the second cross-over channel outlet side port is axially aligned with the first cross-over channel inlet side port.

In yet another form of this aspect of the present invention, the first and second through channels have an axially extending width W, as do the first and second cross-over channel ports, with the axially adjacent ports being spaced at their nearest points a distance S, wherein $S < W$. In a further form, the first and second through channels are substantially cylindrical with a diameter W.

In still another form, the first outlet provides material to a die for covering material provided by the second outlet.

In another aspect of the present invention, a diverter valve is provided for controlling input of two different extruded materials to a mold for molding one of the materials covering the other of the materials. The valve includes a valve body having an axially extending opening therethrough and a valve piston selectively axially movable in the body opening between a first position and a second position. The valve body defines (a) a first inlet in one side adapted to receive a first extruded material, and a second inlet in the one side adapted to receive a second extruded material, the first and second inlets being axially spaced a distance X, (b) a first outlet in the side opposite of the one side, and a second outlet in the opposite side, the first and second outlets being axially spaced the distance X and axially aligned with the first and second inlets, respectively, (c) a first flushing channel communicating with the first inlet and including a first pair of ports at opposite ends open to the axial opening, (d) a second flushing channel communicating with the second inlet and including a second pair of ports at opposite ends opening to the axial opening, and (e) a third flushing channel communicating with the second outlet and including a third pair of ports at opposite ends opening to the axial opening and first and second intermediate ports opening to the axial opening wherein the third pair of ports and first and second intermediate ports are axially aligned with the first and second outlets. The valve piston defines: (i) first and second through channels extending between the one side and the opposite side, the through channels being spaced apart axially by the distance X, (ii) a first cross-over channel having an inlet side port and an outlet side port, the inlet side port being axially spaced from the outlet side port by the distance X, and (iii) a second cross-over channel having an inlet side port and an outlet side port, the second cross-over channel inlet side port being axially aligned with the first cross-over channel outlet side port and the second cross-over channel outlet side port being axially aligned with the first cross-over channel inlet side port. In the first valve piston position, the first through channel connects the first inlet with the first outlet and the second through channel connects the second inlet with the second outlet, the first cross-over channel connects one of the second pair of ports with one of the third pair of ports, the second cross-over channel connects the other of the second pair of ports with the first intermediate port, and the first pair of ports, the other of the third pair of ports, and the second intermediate port are

blocked by the piston. In the second piston position, the first through channel connects one of the first pair of ports with one of the third pair of ports, the second through channel connects the other of the first pair of ports with the second intermediate port, the first cross-over channel connects the first inlet with the second outlet, the second cross-over channel connects the second inlet with the first outlet, the other of the third pair of ports and the first intermediate port are blocked by the piston, and the second pair of ports, the one of the third pair of ports, and the first intermediate port are blocked by the piston.

In yet another form of this aspect of the present invention, the first and second through channels have an axially extending width W, as do the first and second cross-over channel ports, with the axially adjacent ports being spaced at their nearest points a distance S, wherein $S < W$. In a further form, the first and second through channels are substantially cylindrical with a diameter W.

In one form of this aspect of the present invention, the third flushing channel intermediate ports are between the first and second outlet, which are between the third pair of ports, the outlets and the third flushing channel ports being oriented in an axially extending row and spaced from adjacent ports and outlets by a distance of X/3.

In a further or separate form of this aspect of the present invention, the first inlet is between the first pair of ports, the second inlet is between the second pair of ports, one port of the first pair of ports is between the second inlet and one port of the second pair of ports, and the one port of the second pair of ports is between the first inlet and the one port of the first pair of ports, wherein the inlets and the first and second pair of ports are oriented in an axially extending row and spaced from adjacent ports and inlets by a distance of X/3.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is cross-sectional schematic view of a molding system in a first configuration;

FIG. 2 is a cross-sectional schematic view of the molding system of FIG. 1 in a second configuration with the supply of the two materials to the mold swapped from the first configuration;

FIG. 3 is an exploded perspective view of a diverter valve according to the present invention which the operates to control the configuration of the molding system;

FIG. 4 is a perspective partial view of the FIG. 3 diverter valve in the position placing the molding system in the first (straight through) configuration, wherein components are shown semi-transparently to illustrate interior passages in the diverter valve;

FIG. 5 is a view like FIG. 4, showing the diverter valve in the position placing the molding system in the second (cross-over) configuration;

FIG. 6 is an entrance side view of the FIG. 3 diverter valve in the cross-over configuration of FIG. 5;

FIG. 7 is similar to FIG. 6, but showing the diverter valve in an intermediate transitional position between the cross-over configuration and the straight-through configuration; and

FIG. 8 is similar to FIGS. 5 and 6, but showing the diverter valve in the straight-through configuration.

DETAILED DESCRIPTION OF THE INVENTION

While this invention is susceptible of embodiment in many different forms, this specification and the accompanying drawings disclose only one specific form as an example of the use of the invention. The invention is not intended to be

limited to the embodiment so described, and the scope of the invention will be pointed out in the appended claims.

For ease of description, the apparatus operating in accordance with this invention is described in the normal (upright) operating position, and terms such as upper, lower, horizontal, etc., are used with reference to this position.

The apparatus of this invention can have certain conventional components and control mechanisms the details of which, although not fully illustrated or described, will be apparent to those having skill in the art and an understanding of the necessary functions of such components and mechanisms.

Some of the Figures illustrating the preferred embodiment of the apparatus of the present invention show conventional structural details and mechanical elements or components that will be recognized by one skilled in the art. However, the detailed descriptions of such elements are not necessary to an understanding of the invention, and accordingly, are herein presented only to the degree necessary to facilitate an understanding of the novel features of the present invention.

FIGS. 1-2 illustrate a molding system in which a first extruder 20 supplies a first extruded material 22 to a suitable die or mold 26, and a second extruder 30 supplies a second extruded material 32 to the die 26.

In accordance with the present invention, the die 26 may advantageously be of a type used to mold objects having an internal material which is hidden by a covering material over the internal material (note that "objects" is intended to refer not only to discrete, separate items, but also, e.g., continuously molded components which may desirably have different characteristics at different portions of the continuous component). As illustrated in FIG. 1, the die 26 may include a feed block 40, with a first entrance or inlet port 54 connected to the cavity in the die 26 defining the covering portion of the object to be molded, and a second entrance or inlet port 56 connected to mold cavity in the die 26 defining the internal portion of the object.

As will be appreciated with a full understanding of the present invention as further described herein, the details of the die 26 and feed block 40 are important only insofar as they facilitate molding of two materials, where one material covers the other, and any die and/or feed block 40 suitable for such molding would be suitable for use with the present invention.

More particularly, the present invention relates to a diverter valve 50 which may be advantageously used to switch the feed paths of the two extruders 20, 30 so that molded objects may be formed with either of the two materials as the internal material and the other of the two materials as the covering material. Such operation is applicable, for example, to co-extrusion of polymers with colors and/or different blends of polymers where a surface or visual effect is desired (i.e., different color or exterior appearance or feel). Examples include co-extruded sheet where the exterior color is different that the interior and frequent color changes are desired. Switching materials between alternate molding configurations may be advantageously accomplished in a manner which ensures that the switch over is accomplished without spoiling the new covering material (which had been the internal material) with undesirable remnants of the new internal material (which had been the covering material). Thus, as will become apparent from the disclosure herein, frequent color changes may be made on a continuous basis without shutting the in-feeding extruders down for clean out. Further, as will also become apparent, the diverter valve 50 of the present invention will permit continuous flushing of the off-line extruder to occur such that a quick change over can take place at the desired time.

As will be described in greater detail below, the diverter valve 50 in a "straight-through", or extended cylinder, position will direct the first material 22 (e.g., having a first color) provided by the first extruder 20 to the first entrance or inlet port 54 to the die feed block 40, with the second material 32 (having, e.g., a second color different from the first color) provided by the second extruder 30 and directed to a second entrance or inlet port 56 to the die feed block 40. Where the first inlet port 54 supplies extruded material to the skin layer or covering material portion of the die 26, and the second inlet port 56 supplies extruded material to the center layer or internal material portion of the die 26, it will be appreciated that in the FIG. 1 configuration of the diverter valve 50, the molded object will, for example, have an appearance featuring the first color.

Alternatively, the diverter valve 50 in the "cross-over" or "retracted cylinder", position of FIG. 2 (as will be described in greater detail below) will direct the first material 22 (e.g., having a first color) provided by the first extruder 20 to the second entrance or inlet port 56 to the die feed block 40, with the second material 32 provided by the second extruder 30 and directed to the first entrance or inlet port 54 to the die feed block 40. It should be appreciated that in this alternate, FIG. 2 configuration of the diverter valve 50, the molded object will have the second material 32 as its covering material whereby, for example, the molded object would have an appearance featuring the second color (i.e., the color of the second material 32).

Though not shown in the drawings, it should be appreciated that feed to the second inlet port 56 (for the center, interior portion of the molded object) may, in addition to the extruder not being used for the skin layer, also be provided via a third extruder (e.g., when the volume of material on the interior is greater than the volume of material required for the surface of the molded object).

An advantageous diverter valve 50 according to the present invention is illustrated in exploded form in FIG. 3. The valve 50 includes a valve body 60 having an axial opening 62 therethrough. A valve piston 66 is located in the axial opening 62 for slidable axial motion relative to one another as described in further detail hereafter. It should be appreciated that while the central opening 62 and valve piston 66 are not required to be cylindrical in shape, a generally cylindrical shape may nonetheless be advantageously used, with close tolerances between the two desirable, as will become apparent with a full understanding of the present invention.

The valve body 60 and valve piston 66 may advantageously be made from materials which may suitably be polished and hardened to prevent scoring or gulling from occurring during normal operation, and further so that a suitable small tolerance between the outer diameter of the valve piston 66 and inner diameter of the valve body 60 may be accomplished to prevent leaking of polymer from occurring. Such tolerances also serve to prevent cross flow from occurring between adjacent flow-channels that are characteristic in the valve piston 66 as described further below.

As described in greater detail hereafter, the valve body 60 includes a plurality of channels defined therein. In the illustrated embodiment, a plurality of port plugs 70, 72, 74, 76, 78 and associated securing screws 80, 82, 84, 86, 88 are provided to close openings in the valve body 60 which are not required during operation but which may be created to allow access for machining of the valve body channels, which may require drilling from outside the valve body 60. The port plugs 70-78 may advantageously be machined on the end to provide smooth flow surfaces at the channels. Further, the port plugs 70-76 and associated securing screws 80-86 (particularly the

plugs **70, 76** and screws **80, 86** on the entrance and exit sides of the valve body **60** may be recessed into the valve body **60** to avoid interference, for example with adapters which may be required to be bolted to the surface of the body **60** during installation.

The valve body **60** also includes two outlets **90, 92** on the exit side **94** of the body **60** (see FIG. 3) and two inlets **96, 98** on the entrance side **100** of the body **60** (note that the entrance side **100** may be best seen in FIGS. 4-5.) The outlets **90, 92** and inlets **96, 98** extend through the body **60** to its central opening **62**, with the first outlet **90** axially aligned with the first inlet **96** and the second outlet **92** axially aligned with the second inlet **98**. Further, the outlets **90, 92** have a predetermined, known axial spacing X between each other, and the inlets **96, 98** are similarly axially spaced by the known distance X .

A mounting bracket **110** is secured to one end of the valve body **60** and to the valve piston **66** for controlling the axial position of the piston **66** in the valve body **60** while reliably preventing rotation of the piston **66** relative to the body **60**.

The bracket **110** includes a cylinder mounting plate **114** suitably secured in a spaced relationship from the end of the body **60** by cylinder extensions **118**. As illustrated, the cylinder extensions **118** are screwed into threaded openings **120** at the end of the valve body **60**, with the mounting plate **114** secured to the other end of the extensions **118** by, for example, bolts **122**.

An anti-rotation bracket **130** is suitably secured to one end of the valve piston **66** (e.g., by suitable bolts or pins **134**). The anti-rotation bracket **130** is also slidably connected to one of the cylinder extensions **118**, for example, via a semi-cylindrical recess **136** in which the one cylinder extension **118** is received.

A suitable hydraulic cylinder **140** is secured to the mounting plate **114** (e.g., by suitable bolts **142**). The cylinder rod **146** of the hydraulic cylinder **140** is suitably secured to the anti-rotation bracket **130** (e.g., by a cylinder rod extension **148**).

It should thus be appreciated that the hydraulic cylinder **140** can be actuated to move the anti-rotation bracket **130** and connected valve piston **66** axially relative to the valve body **60** while at the same time ensuring that the valve piston is not rotated relative to the valve body **60**.

Cartridge heaters **150** may advantageously be provided along the length of the valve body **60**, and cartridge heaters **152** may also be provided along the length of the valve piston **66** (e.g., within axial bores in the body **60** and piston **66**) to ensure that the valve **50** be at suitable temperature for passing the extruded materials therethrough. The heaters **150, 152** may, for example, be electric cartridge style heaters, and may be controlled to control temperatures in separate zones to assure precise temperature is maintained. It should also be noted that the mounting bracket **110**, and the cylinder rod extension **148**, enable the hydraulic cylinder **140** to control the position of the piston **66** relative to the body **60** while at the same time maintaining a distance which prevents the hydraulic cylinder **140** from being overheated by the heat from the cartridge heaters **150, 152**.

The valve piston **66** includes a number of channels for passage of extruded material depending on the condition of the diverter valve **50** (i.e., the position of the valve piston **66**) as described in detail below.

Specifically, the piston **66** includes first and second through channels **200, 202** which each extend along a radius of the piston **66** from one side to the other. The channels **200, 202** are

axially spaced apart by a distance X substantially equal to the axial spacing of the two outlets **90, 92** (and the two inlets **96, 98**) of the valve body **60**.

Additionally, first and second bypass or cross-over channels **210, 212** are provided in the outer surface of the piston **66**. These cross-over channels **210, 212** essentially cross-over from one side to the other, so that the first cross-over channel **210** has an inlet port **216** on one end which is axially spaced from its outlet port **218** on the other end by the distance X (i.e., substantially equal to the axial spacing of two valve body outlets **90, 92** and the axial spacing of the two valve body inlets **96, 98**). The second cross-over channel **212** extends axially in the opposite direction of the first, but similarly has an inlet port **220** on one end which is axially spaced from its outlet port **222** on the other end by the distance X . Moreover, the inlet port **216** of the first cross-over channel **210** is axially aligned with the outlet port **222** of the second cross-over channel **212**, and the outlet port **218** of the first cross-over channel **210** is axially aligned with the inlet port **220** of the second cross-over channel **212**.

The valve body **60** includes a plurality of flow channels for the extruded material as best shown in the simplified, semi-transparent view of FIGS. 4-5.

More specifically, the outer (exit and entrance) sides **94, 100** of the valve body **60** each include two openings allowing passage of extruded material into (via inlets **96, 98** on entrance side **100**) and out of (via outlets **90, 92** on exit side **94**) the valve body **60**.

Moreover, on each of the inner sides of the valve body **60** there are six axially spaced ports (ports **301, 302, 303, 304, 305, 306** adjacent the exit side **94** of the body central opening **62**, and ports **311, 312, 313, 314, 315, 316** adjacent the entrance side **100** of the body central opening **62**) which are open into the body central opening **62**, with each of the six being radially aligned with one of the ports on the opposite inner side.

Advantageously, the ports on each side may be evenly spaced in an axial direction, with adjacent ports spaced center-to-center by a distance substantially equal to one third the axial spacing X of the outlets **90, 92** and inlets **96, 98** (i.e., $X/3$). As described in greater detail hereafter, the ports **301-306** and **311-316** will, depending on the position of the valve piston **66**, be either blocked shut by the valve piston **66** or in communication with one of the through channels **200, 202** or cross-over channels **210, 212** of the valve piston **66**.

In the valve body **60** on opposite sides of the body central opening **62** are a plurality of flushing channels. Specifically:

- i) A first flushing channel **330** communicates with the inlet **96** as well as to ports **311, 312** and **314**. Ports **311** and **314** are at the end of the channel **330**, with port **312** aligned with inlet **96** between ports **311** and **314**.
- ii) A second flushing channel **334** communicates with the inlet **98** and ports **313, 315** and **316**. Ports **313** and **316** are at the end of the channel **334**, with port **315** aligned with inlet **98** between ports **313** and **316**.
- iii) A third flushing channel **338** (on the exit side **94**) communicates with the second outlet **92** and ports **301** and **303-306**. Ports **302** and **305** are aligned with outlets **90, 92** respectively, with ports **301** and **306** being end ports and ports **303** and **304** being intermediate ports positioned between the outlets **90, 92**.

Because the straight-through channels **200, 202** and the cross-over channels **210, 212** are intended to carry more material flow volume than the flushing channels, **330, 334, 338**, those channels **200, 202, 210, 212** are larger in diameter or cross-sectional area than the flushing channels **330, 334, 338**. As a result, the ports which are connected to one of the

flushing channels **330, 334, 338** and open to the axial opening **62** in the body **60** (i.e., ports **301, 303, 304, 306, 311, 313, 314, 316**) are preferably tapered outwardly, or bell shaped, to provide an opening size which will match the size of the straight-through channels **200, 202** and the inlet and outlet ports **216, 218, 220, 222** of the cross-over channels **210, 212**. This configuration thus avoids transverse surfaces which might otherwise undesirably project into the flow path during either of the normal operating positions.

The flushing channels **330, 334, 338** provide continuously cleaning of the unused flow passages in the valve piston **66**, which is particularly useful for quick color change-over. Additionally, the valve **50** may serve as a structural element permitting high pressure adapters to interconnect the in-feeding extruders **20, 30**, where the extruder **20** or **30** that is not online is can be flushed continuously into a region of the end product that is not esthetic or visible while the other extruder **30** or **20** is feeding the color or primary exiting port of the flow network.

As previously noted, this valve **50** may be advantageously used to mold a piece having, for example, an internal material covered by a different covering material, where the piece can alternately be made of two colors. That is, by providing a first extruded material of one color and a second extruded material having a second, different, color, the color of the molded object can be changed by changing which material is fed to the internal cavity forming the internal portion of the piece and which material is fed to the covering cavity forming the covering portion of the piece.

Specifically, in the configuration illustrated in FIGS. **1** and **4**, the valve piston **66** is in an extended position (i.e., the cylinder rod **146** is extended from the hydraulic cylinder **140**), wherein the through channel **200** connects inlet **96** with outlet **90**, and through channel **202** connects inlet **98** with outlet **92**. Thus, as schematically illustrated in FIG. **1**, material from the first extruder **20** will be supplied to inlet **96**, and then through port **312** into through channel **200**, out port **302** and out outlet **90** to the die inlet port **54** from which the material is used to form the surface portion or skin of the molded object. Material from the second extruder **30** will be supplied to inlet **98**, and then through port **315** into through channel **202**, out port **305** and out outlet **92** to the die inlet port **56** where that material is used to form the interior or center layer portion of the molded object.

When it is desired to switch the use of the different extruded materials, the cylinder rod **146** is retracted to the retracted (or cross-over) position shown in FIGS. **2** and **5**.

In the retracted position, the first cross-over channel **210** has its inlet port **216** communicating with inlet **96** and its outlet port **218** communicating with outlet **92**, and the second cross-over channel **212** has its inlet port **220** communicating with inlet **98** and its outlet port **222** communicating with outlet **90**. Thus, material from the first extruder **20** will be supplied from the inlet **96** and then, via the first cross-over channel **210**, to the second outlet **92** and on to the die inlet port **56**, and material from the second extruder **30** will be supplied from the inlet **98** and then, via the second cross-over channel **212**, to the first outlet **90** and on to the die inlet port **54**. In the example used herein, the different material (e.g., having a different color) from the second extruder **30** is thus supplied to form the surface of the molded object and the material from the first extruder **20** is then supplied to form the interior portion of the molded object.

Moreover, it should be appreciated that no matter which valve piston channels (**200, 202**, or **210, 212**) are used in a particular configuration, the other channels (**210, 212** or **200,**

202) will be flooded with material to facilitate proper continuing operation whenever the configuration of the diverter valve **50** is changed. That is:

- a. When the valve piston **66** is in the extended position (FIG. **4**) in which the through ports **200, 202** are used to carry material to the die inlet ports **54, 56**, respectively (i.e., with material from the first extruder **20** carried via inlet **96** through port **200** to die inlet port **54** to form the object surface, and material from the second extruder **30** carried via inlet **98** through port **202** to die inlet port **56** to form the center layer portion);
 - i. The cross-over channels **210, 212**, though not carrying material to the die **26**, are nonetheless advantageously kept flooded with extruded material from the second extruder **30** (i.e., the material used to form the center layer portion). Such flooding occurs via material flow from the second extruder **30** via inlet **98** and then in the second and third flushing channels **334, 338** (through ports **303, 313, 306, 316**).
 - ii. Flow of the material from the second extruder **30** in those flushing channels **334, 338** is isolated from the material from the first extruder **20**. That is, in addition to flow of the material from the first extruder **20** through channel **200**, flow of that material is connected only to the first flushing channel **330** (which dead heads at ports **311** and **314** against the side of the valve piston **66**). Accordingly, the interior material (from the second extruder **30** entering inlet **98**) will not undesirably pollute the intended flow of the surface material (which flows straight through via channel **200**), and therefore will not risk giving the surface material an undesired color and/or texture or mixtures thereof.
- b. When the valve piston **66** is in the retracted position (FIG. **5**) in which the cross-over ports **210, 212** are used to carry material to the die inlet ports **56, 54** (i.e., with material from the first extruder **20** carried via inlet **96** through cross-over port **210** to die inlet port **56** to form the object center layer portion, and material from the second extruder **30** carried via inlet **98** through cross-over port **212** to die inlet port **54** to form the object surface):
 - i. The through channels **200, 202** are similarly advantageously kept flooded with extruded material from the first extruder **20** (which, in this configuration, is similarly the material used to form the center layer portion). Such flooding occurs via material flow in the first and third flushing channels **330, 338** (through ports **301, 311, 304, 314**). Moreover, allowing such flow will minimize pressure spikes and flow interruptions.
 - ii. Flow of the material from the first extruder **20** in those flushing channels **330, 338** is similarly isolated from the material from the second extruder **30**. That is, flow of the material from the second extruder **30** is connected only to the second flushing channel **334** (which dead heads at ports **313** and **316** against the side of the valve piston **66**). Accordingly, the interior material (from the first extruder **20** entering inlet **96** in this configuration) will similarly not undesirably pollute the intended flow of surface material (flowing through isolated cross-over channel **212**).
- c. To the extent that any residual material flows (i.e., is not deadheaded) in flushing channels **330, 334, 338** after a change of configuration, the material flows toward the outlet **92** which is connected to the die inlet port **56** for the interior of the molded object (where any such mixture of materials is not critical).

Additionally, it should be appreciated that even during transitioning between the straight-through position (FIGS. **1**

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and 4) and cross-over positions (FIGS. 2 and 5) will not be blocked or "dead headed". That is, the spacing S between adjacent sides of the ports (i.e., on the body exit side 94, between port 301 and port 302, port 302 and port 303, port 303 and port 304, port 304 and port 305, and port 305 and 306, 5 and on the entrance side 100 between port 311 and port 312, port 312 and port 313, port 313 and port 314, port 314 and port 315, and port 315 and 316) is less than the width (diameter D) of the through channels 200, 202 and inlet ports 96, 98 of the cross-over channels 210, 212. 10

Therefore, as illustrated in FIGS. 6-8, when the valve piston 66 is moved from the cross-over position (FIG. 6) to the straight-through position (FIG. 8) (by moving toward the right in FIGS. 6-8), before any of the through channels 200, 202 and cross-over channels 210, 212 are fully disengaged 15 from the ports with which they were aligned in the cross-over position, they will begin opening to the ports with which they will be aligned when in the straight-through position as clearly illustrated in FIG. 7.

For example, during transitioning from the cross-over position (FIG. 6), the through channel 200 will shift from port 311 to port 312 and, during that transition, before the through channel 200 fully disengages from port 311 to terminate flow therein, the through channel 200 will begin connecting with port 312. Similarly, viewed from the perspective of a port, for 25 example, port 312, when the valve 66 moves toward the straight-through position from the cross-over position, flow through port 312 gradually decreases as its connection with cross-over channel 210 reduces. However, before the cross-over channel 210 is completely disconnected from the port 30 312, the port 312 begins to be connected to the straight-through channel 200. Thus, at no point is flow through port 312 completely blocked.

This same transition occurs, of course, when moving from the straight-through position (FIG. 8) to the cross-over position (FIG. 6). 35

As a result, undesirable pressure spikes which can occur when a flow line is fully blocked can be virtually eliminated

It should thus be appreciated that a diverter valve 50 incorporating the present invention may be used in molding applications in which the molded object has two discrete parts 40 formed from two different materials. The present invention allows such operation to be accomplished while preventing problems in channels or passages which may not be used during a particular operation by keeping all of the channels or passages flush with extruded material. Moreover, where the purity of one of the materials is critical (e.g., where one of the materials is the visible portion of the molded object which must have a certain color and/or texture), the present invention allows switching the two materials in a manner which 45 ensures that whichever of the materials is being used as the one critically requiring purity will, in fact, be pure without being polluted with the other material.

Still other aspects, objects, and advantages of the present invention can be obtained from a study of the specification, the drawings, and the appended claims. It should be understood, however, that the present invention could be used in alternate forms where less than all of the objects and advantages of the present invention and preferred embodiment as described above would be obtained. 50 55 60

The invention claimed is:

1. A diverter valve for controlling input of two different extruded materials to a mold for molding one of said materials covering the other of said materials, comprising: 65

a valve body having an axially extending opening there-through;

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a valve piston selectively axially movable in said body opening between a first position and a second position; wherein:

said valve body defines

- a first inlet in one side adapted to received a first extruded material, and a second inlet in said one side adapted to receive a second extruded material,
- a first outlet in the side opposite of said one side, and a second outlet in the opposite side,
- a first flushing channel communicating with said first inlet and including end ports open to said axial opening,
- a second flushing channel communicating with said second inlet and including end ports opening to said axial opening, and
- a third flushing channel communicating with said second outlet and including a plurality of ports opening to said axial opening,

said piston defines

- first and second through channels extending between said one side and said opposite side,
- a first cross-over channel having an inlet side port and an outlet side port, and
- a second cross-over channel having an inlet side port and an outlet side port;

whereby

- in said first position,
 - said first through channel connects said first inlet with said first outlet and said second through channel connects said second inlet with said second outlet,
 - said valve piston blocks said end ports of said first flushing channel, and
 - said first and second cross-over channels connect said second and third flushing channels to allow flow of material therein from the second inlet, and
- in said second position;
 - said first cross-over channel connects said first inlet with said second outlet and said second cross-over channel connects said second inlet with said first outlet,
 - said valve piston blocks said end ports of said second flushing channel, and
 - said first and second through channels connect said first and third flushing channels to allow flow of material therein from the first inlet.

2. The diverter valve of claim 1, wherein flow of material from the flushing channels to the first outlet is blocked in both said first and second positions of said valve piston.

3. The diverter valve of claim 1, wherein said first and second inlets are axially spaced a distance X, and said first and second outlets are axially spaced the distance X, said first and second through channels are axially spaced the distance X, said inlet side port of said first cross-over channel and said inlet side port of said second cross-over channel are axially spaced the distance X, and said outlet side port of said first cross-over channel and said outlet side port of said second cross-over channel are axially spaced the distance X.

4. The diverter valve of claim 3, where said second cross-over channel inlet side port is axially aligned with said first cross-over channel outlet side port and said second cross-over channel outlet side port is axially aligned with said first cross-over channel inlet side port.

5. The diverter valve of claim 1, wherein said first and second through channels have an axially extending width W; said first and second cross-over channel ports have an axially extending width W; and

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the axially adjacent ports are spaced at their nearest points
a distance S;
wherein $S < W$.

6. The diverter valve of claim 5, wherein said first and second through channels are substantially cylindrical with a diameter W.

7. The diverter valve of claim 1, wherein said first outlet provides material to a die for covering material provided by the second outlet.

8. A diverter valve for controlling input of two different extruded materials to a mold for molding one of said materials covering the other of said materials, comprising:

a valve body having an axially extending opening there-through;

a valve piston selectively axially movable in said body opening between a first position and a second position;

wherein:

said valve body defines

a first inlet in one side adapted to receive a first extruded material, and a second inlet in said one side adapted to receive a second extruded material, said first and second inlets being axially spaced a distance X,

a first outlet in the side opposite of said one side, and a second outlet in the opposite side, said first and second outlets being axially spaced the distance X, and axially aligned with said first and second inlets, respectively,

a first flushing channel communicating with said first inlet and including a first pair of ports at opposite ends open to said axial opening,

a second flushing channel communicating with said second inlet and including a second pair of ports at opposite ends opening to said axial opening, and a third flushing channel communicating with said second outlet and including

a third pair of ports at opposite ends opening to said axial opening, and

first and second intermediate ports opening to said axial opening,

wherein said third pair of ports and first and second intermediate ports are axially aligned with said first and second outlets; and

said piston defines

first and second through channels extending between said one side and said opposite side, said through channels being spaced apart axially by the distance X,

a first cross-over channel having an inlet side port and an outlet side port, said inlet side port being axially spaced from the outlet side port by the distance X, and

a second cross-over channel having an inlet side port and an outlet side port, said second cross-over channel inlet side port being axially aligned with said first cross-over channel outlet side port and said second cross-over channel outlet side port being axially aligned with said first cross-over channel inlet side port;

whereby

in said first position,

said first through channel connects said first inlet with said first outlet and said second through channel connects said second inlet with said second outlet, said first cross-over channel connects one of said second pair of ports with one of said third pair of ports,

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and said second cross-over channel connects the other of said second pair of ports with said first intermediate port, and

said first pair of ports, the other of said third pair of ports, and the second intermediate port are blocked by said piston,

in said second position,

said first through channel connects one of said first pair of ports with one of said third pair of ports, and said second through channel connects the other of said first pair of ports with the second intermediate port,

said first cross-over channel connects said first inlet with said second outlet, and said second cross-over channel connects said second inlet with said first outlet,

said other of the third pair of ports and the first intermediate port are blocked by said piston, and

said second pair of ports, said one of said third pair of ports, and the first intermediate port are blocked by said piston.

9. The diverter valve of claim 8, wherein

said first and second through channels have an axially extending width W;

said first and second cross-over channel ports have an axially extending width W; and

the axially adjacent ports are spaced at their nearest points a distance S;

wherein $S < W$.

10. The diverter valve of claim 9, wherein said first and second through channels are substantially cylindrical with a diameter W.

11. The diverter valve of claim 8, wherein said first inlet is between said first pair of ports, said second inlet is between said second pair of ports, one port of said first pair of ports is between said second inlet and one port of said second pair of ports, and said one port of said second pair of ports is between said first inlet and said one port of said first pair of ports, wherein said inlets and said first and second pair of ports are oriented in an axially extending row and spaced from adjacent ports and inlets by a distance of $X/3$.

12. The diverter valve of claim 8, wherein said third flushing channel intermediate ports are between the first and second outlet, which are between the third pair of ports, said outlets and said third flushing channel ports being oriented in an axially extending row and spaced from adjacent ports and outlets by a distance of $X/3$.

13. The diverter valve of claim 12, wherein said first inlet is between said first pair of ports, said second inlet is between said second pair of ports, one port of said first pair of ports is between said second inlet and one port of said second pair of ports, and said one port of said second pair of ports is between said first inlet and said one port of said first pair of ports, wherein said inlets and said first and second pair of ports are oriented in an axially extending row and spaced from adjacent ports and inlets by a distance of $X/3$.

14. A diverter valve for controlling input of supplies of first and second extruded materials to a mold for molding one of said materials covering the other of said materials, the diverter valve comprising:

a first inlet adapted to receive a first extruded material;

a second inlet adapted to receive a second extruded material;

a first outlet;

a second outlet,

the valve configured to change between:

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a) a first state wherein said first inlet is connected to said first outlet and said second inlet is connected to said second outlet, and

b) a second state wherein said first inlet is connected to said second outlet and said second inlet is connected to said first outlet;

wherein said diverter valve is configured so that when switching said diverter valve from said first state to said second state,

said first inlet is connected to said second outlet before disconnecting from said first outlet, and said second inlet is connected to said first outlet before disconnecting from said second outlet; and

when switching said diverter valve from said second state to said first state,

said first inlet is connected to said first outlet before disconnecting from said second outlet, and said second inlet is connected to said second outlet before disconnecting from said first outlet.

15. A diverter valve for controlling input of first and second extruded materials to a mold for molding one of said materials covering the other of said materials comprising:

a valve body having a first inlet adapted to receive a first extruded material, a second inlet adapted to receive a second extruded material, a first outlet, and a second outlet;

a valve member selectively movable relative to said valve body between

a first position connecting said first inlet to said first outlet and said second inlet to said second outlet, and a second position connecting said first inlet to said second outlet and said second inlet to said first outlet;

wherein said valve body and valve member are configured so that

when switching said diverter valve from said first state to said second state,

said first inlet is connected to said second outlet before disconnecting from said first outlet, and said second inlet is connected to said first outlet before disconnecting from said second outlet; and

when switching said diverter valve from said second state to said first state,

said first inlet is connected to said first outlet before disconnecting from said second outlet, and said second inlet is connected to said second outlet before disconnecting from said first outlet.

16. A diverter valve for controlling input of first and second extruded materials to a mold for molding one of said materials covering the other of said materials, comprising:

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a valve body having an opening therein with a first inlet adapted to receive a first extruded material, a second inlet adapted to receive a second extruded material, a first outlet, and a second outlet;

a valve piston selectively movable in said body opening between a first position and a second position, said valve piston defining

a first channel connecting said first inlet to said first outlet when said valve position is in said first position, and

a second channel connecting said second inlet to said first outlet when said valve position is in said second position;

wherein:

said second channel connects said second inlet to said second outlet when said valve piston is in said first position,

said first channel connects said first inlet to said second outlet when said valve piston is in said second position, and

said first and second channels at all valve piston positions connect at least one of said inlets to at least one of said outlets.

17. A diverter valve for controlling input of first and second extruded materials to a mold for molding one of said materials covering the other of said materials, comprising:

a valve body having an opening therein with a first inlet adapted to receive a first extruded material, a second inlet adapted to receive a second extruded material, a first outlet, and a second outlet;

a valve piston selectively movable in said body opening between a first position and a second position, said valve piston defining

a first channel connecting said first inlet to said first outlet when said valve position is in said first position, and

a second channel connecting said second inlet to said first outlet when said valve position is in said second position; and

a plurality of flushing channels

connecting said second inlet to said second outlet when said valve piston is in said first position, and connecting said first inlet to said second outlet when said valve piston is in said second position,

wherein:

said second channel is one of said flushing channels when said valve piston is in said first position, and

said first channel is one of said flushing channels when said valve piston is in said second position.

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