(12) UK Patent Application (19) GB (11) 2 412 617 (13) A

(43) Date of A Publication 05.10.2005

(21) Application No: 0507371.3

(22) Date of Filing: 12.04.2005

(30) Priority Data:
(31) 10/817025 (32) 02.04.2004 (33) US

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(51) INT CL[7]:
B05B 7/32 , B01F 15/02 , B05B 7/04 7/16 , B05D 1/02 ,
B29C 41/08 44/36 , B60R 13/00

(52) UK CL (Edition X):
B2L LCDF
B5A AD33 AT8P A1R314C5 A1R445 A2A1 A7B

(56) Documents Cited:
GB 2403449 A US 4096585 A

(58) Field of Search:
UK CL (Edition X) B2L
INT CL[7] B05B
Other: Online: EPODOC, WPI

(54) Abstract Title: **Method and apparatus for spray forming polyurethane skins with a hydraulic mixing head.**

(57) An apparatus (10) for spraying polyurethane to form a skin on a mold. Polyurethane forming constituents are provided from a plurality of separate supply sources (56) to separate recirculating fluid circuits. A mix head (12) receives polyurethane constituents from the fluid circuits and mixes them to form a polyurethane mixture. A hydraulically operated valve (24) controls the flow of the polyurethane constituents. The valve (24) has a first position in which the polyurethane components are permitted to flow into the chamber (30) of the mix head (12). The polyurethane mixture is then dispensed through a spray nozzle assembly (14). When the valve (24) is in a second position, the polyurethane constituents are recirculated through the fluid circuits (26,28, 68,70). A liquid solvent may be injected into the mix head (12) under pressure to purge the mixture from the mix head (12) and spray nozzle assembly (14) in the second position.

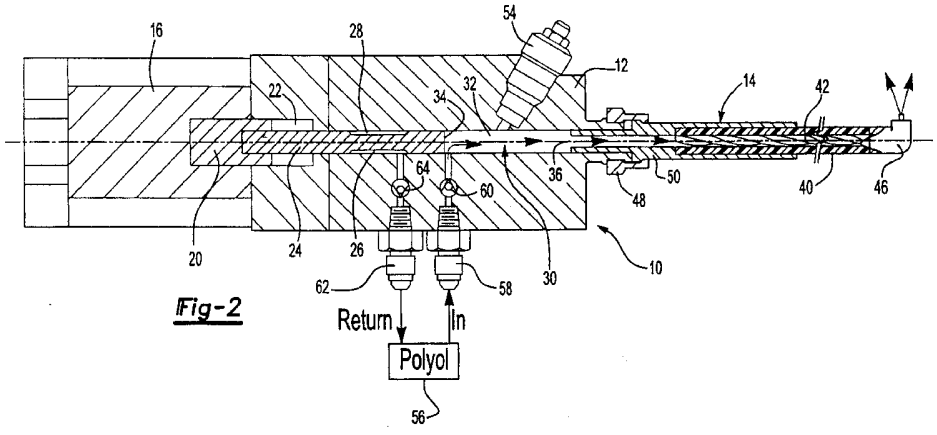

Fig-2

The priority details shown above contain a late declaration of priority made under Section 5(2B) and Rule 6A.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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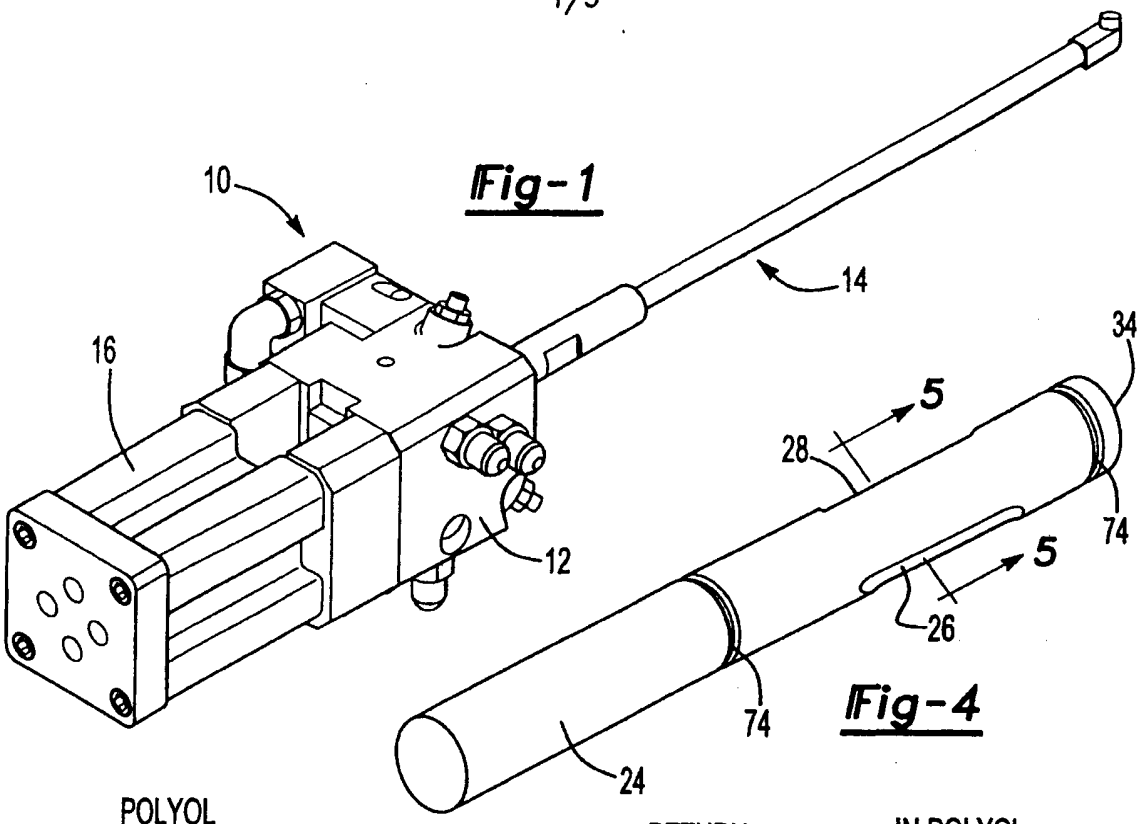


Fig-1

Fig-4

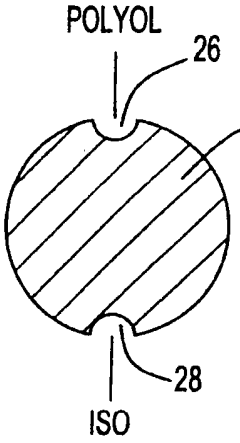


Fig-5

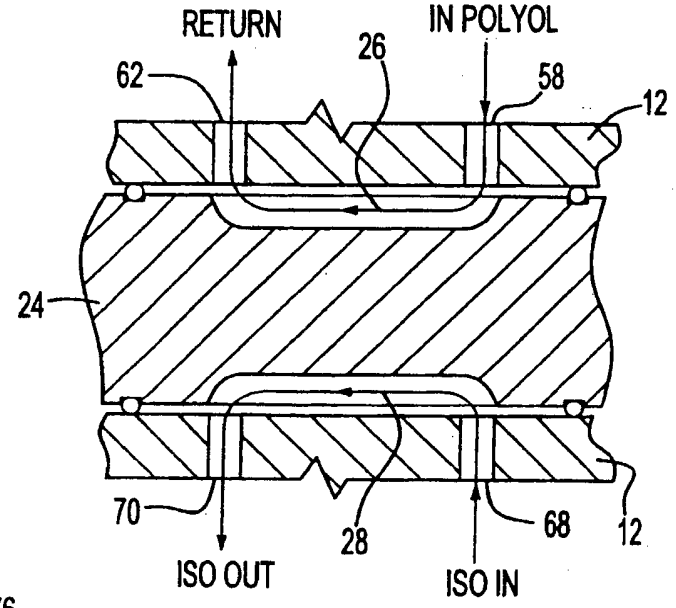


Fig-6

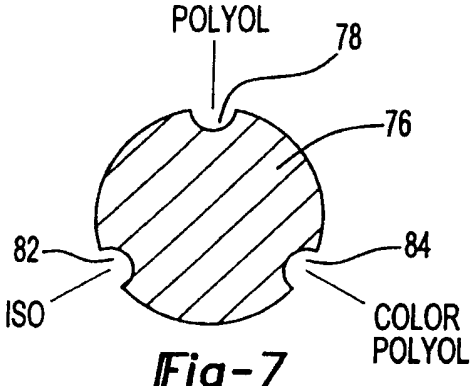
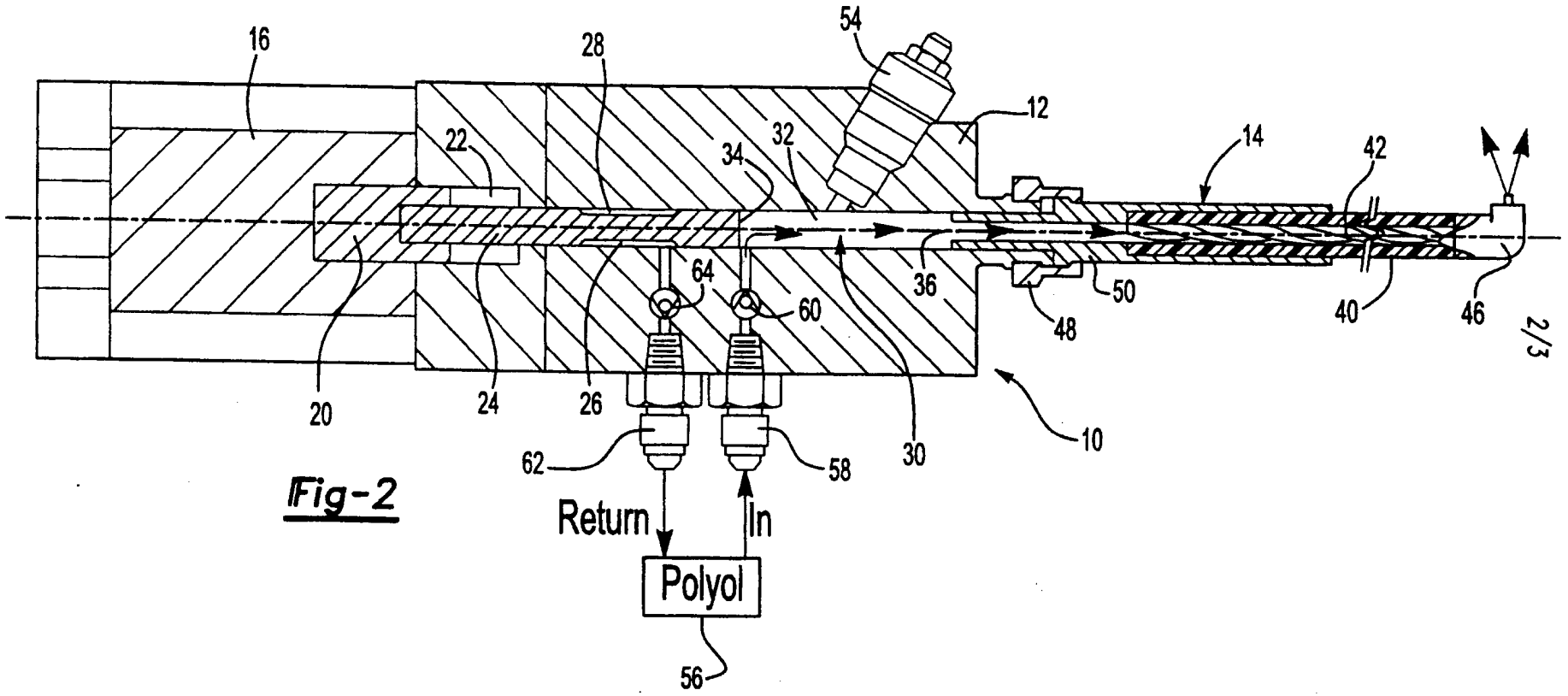


Fig-7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Polyol
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Fig-2

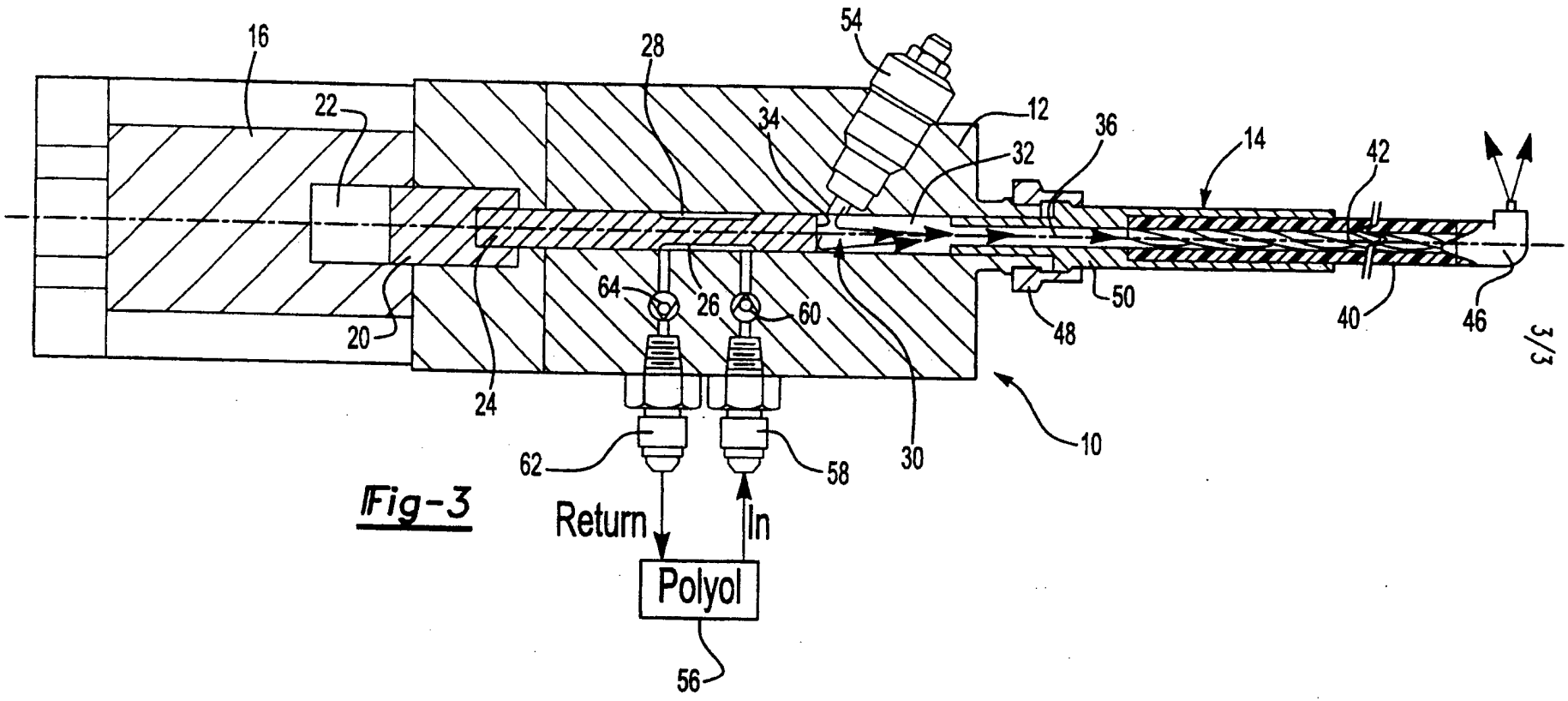
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Fig-3

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METHOD AND APPARATUS FOR SPRAY FORMING POLYURETHANE SKINS WITH A HYDRAULIC MIXING HEAD

The present invention relates to an apparatus and method for spray forming a polyurethane skin to be used in manufacturing a vehicle interior component.

For many years, vehicle interior parts have been formed by providing a skin formed in the shape of the interior part that is filled with foam material and may also be assembled to a structural member. Vinyl skins are formed in rotocasting operations in which liquid vinyl is poured into a closed, heated mold that is rotated to coat the mold with the vinyl composition. The vinyl composition cures as a hollow skin conforming to the mold surface. While this process has been used to form high quality parts, considerations relating to the difficulty of recycling vinyl parts and minimizing volatile organic compositions in vehicle interiors is causing original equipment manufacturers to reduce the use of vinyl parts in vehicle interiors. Polyurethane skins are being developed to replace vinyl skins in interior components. Polyurethane materials reduce the quantity of volatile organic compositions in interior parts. Rotocasting polyurethane is not favored because thermoplastic polyurethane materials that may be used are very expensive aliphatic materials.

Prior art polyurethane spray systems rely upon pneumatic mixing heads that are subject to many disadvantages and limitations. Such mixing heads are generally designed to handle two chemical components. Pneumatic mixing heads tend to malfunction when spraying higher viscosity materials. Pneumatic mixing heads may be adversely affected by the

quality and quantity of compressed air that is available. Pneumatic mixing heads do not recirculate through the mix head, but through a recirculation block mounted above the mixing head. Pneumatic mixing heads are not normally capable of maintaining polyurethane constituents at the desired temperature for spray forming polyurethane skins on a mold.

There is a need for a robust mixing head that is well adapted to dispensing high viscosity polyurethane components and mixtures.

There is also a need for a mixing head that provides a more uniformspray pattern and that does not rely on external screw adjustments to seat the injection pin in an orifice.

There is a further need for a recirculation circuit that facilitates maintaining the temperature of heated polyurethane forming constituents as the material recirculates until it is introduced into the spray tool mixing head.

There is a need for a mixing head for mixing polyol and isocyanate with a pigmented polyurethane forming component.

In addition there is a need for an improved apparatus and method which offers improvements generally.

According to the present invention there is provided a spray tool apparatus for spraying polyurethane, and a method of forming a polyurethane skin, as described in the accompanying claims.

The above problems are addressed and needs are fulfilled

by the present invention.

In an embodiment of the invention there is provided an apparatus for spraying polyurethane is provided. The apparatus includes a plurality of supply sources containing one of a plurality of polyurethane constituents. A plurality of recirculating fluid circuits are each in fluid flow communication with one of the supply sources. A mix head is connected to each of the fluid circuits and receives from each fluid circuit one of the polyurethane constituents. The mix head has a chamber in which the polyurethane constituents are mixed to form a polyurethane mixture. A hydraulically operated valve controls the flow of polyurethane constituents to the mix head. The valve has a first position in which the polyurethane constituents flow into a mixing chamber in the mix head, and a second position in which the polyurethane constituents are recirculated through the fluid circuit without being mixed in the mixing chamber. A spray nozzle assembly dispenses the polyurethane mixture when the valve is in the first position.

The polyurethane constituents may be polyol, isocyanate, and pigmented polyol that are provided by separate recirculating fluid circuits. The recirculating fluid circuitsmay each have a separate pump for providing one of the polyurethane constituents under pressure. A liquid solvent may be supplied to the mix head to purge the polyurethane mixture from the chamber in the mix head and the spray gun when the valve is in the second position.

The hydraulically operated valve may have a hydraulically actuated piston that is provided with separate

channels through which each of the polyurethane constituents flow when the valve is in the second position. The hydraulically operated valve may be operated by a hydraulic fluid circuit that has a reciprocating piston that shifts the valve between the first and second positions. The reciprocating piston shifts a valve spool within an elongated chamber. The valve spool and chamber are sealed relative to each other as the valve spool moves between the first and second positions. A seal may be secured to the valve spool to assure that a seal is established between the spool and chamber.

The spray gun may have a tubular portion and a static helical mixing vane disposed in the tubular portion that mixes the polyurethane mixture as it is dispensed. The mixture of polyurethane may be sprayed by the spray nozzle assembly on a mold toform a polyurethane skin for a vehicle interior part.

Another aspect of an embodiment of the present invention relates to the method that is used to form a polyurethane skin for an interior part of the vehicle. The method comprises pumping an isocyanate composition and polyol composition to the mix head. A valve is selectively opened in a first position to allow the polyol composition and isocyanate composition to be injected under pressure into a mixing chamber defined by the mix head to create a polyurethane reactant mixture. The valve is selectively closed in a second position to allow the polyol composition and isocyanate composition to be recirculated. The valve is moved by a hydraulically actuated cylinder that moves a valve element within a valve body between the first and second positions. The polyurethane reactant mixture is dispensed through a spray

nozzle assembly and shaped on a mold surface to form a polyurethane skin.

An alternative embodiment of the method may be practised wherein a pigmented polyol composition is pumped to the mix head in addition to the isocyanate and polyol constituents as described above. The three constituents are injected in a first position into the mix head under pressure to create a pigmented polyurethane reactant mixture. The valve may be selectively closed in a second position to recirculate the three constituents. The pigmented polyurethane reactant mixture is dispensed through a spray nozzle assembly and shaped on a mold surface to form the polyurethane skin with the desired pigmentation.

Other aspects of the invention as they relate to the above methods may further comprise mixing the reactants with a static helical mixing vane disposedin a tubular portion of the spray nozzle assembly. The method may further comprise spraying a solvent into the mixing chamber when the valve is in the second position to purge the polyurethane reactant mixture from the mixing chamber and spray nozzle assembly. The valve element used in the method may further comprise a piston that is provided with separate channels for each of the reactant compositions when the valve is in the second position.

These and other aspects of the invention will be better understood in view of the attached drawings and following detailed description and preferred embodiments of the invention in which:-

FIGURE 1 is a perspective view of a spray tool apparatus for spraying polyurethane made according to the present invention;

FIGURE 2 is a longitudinal cross-sectional view of the spray tool apparatus in a first position;

FIGURE 3 is a longitudinal cross-sectional view of the spray tool apparatus in a second position;

FIGURE 4 is a perspective view of a valve piston for the spray tool apparatus;

FIGURE 5 is a cross-sectional view taken along the line 5-5 in Figure 4;

FIGURE 6 is a diagrammatic cross-sectional view showing the valvepiston in its recycling position; and

FIGURE 7 is a transverse cross-section of an alternative embodimentof the valve piston that may be used to spray three components to form a colored polyurethane mixture.

Referring to Figure 1, a spray tool apparatus 10 is shown to includea mix head 12 that is connected to a nozzle assembly 14. The mix head 12 is operated by means of a hydraulic actuator 16. The spray tool apparatus 10 is used to form a polyurethane skin by mixing and spraying polyurethane constituents through the nozzle assembly 14.

Referring to Figures 2 and 3, the spray tool apparatus

10 is shown in cross-section to illustrate the functional relationship of the mix head 12, nozzle assembly 14 and hydraulic actuator 16. A hydraulic piston 20 is disposed in a chamber 22 for moving a valve piston 24 between a first position shown in Figure 2 and a second position shown in Figure 3. Valve piston 24 in the illustrated embodiment has a first channel 26 and a second channel 28 formed on the sides ofthe valve piston 24.

A mixing chamber generally indicated by reference numeral 30 comprises a cavity 32 that is closed on one end by a distal end 34 of the valve piston 24. The mixing chamber 30 has an outlet 36 on the opposite end from the distal end 34 of the valve piston 24 through which a polyurethane mixture may be sprayed asillustrated by the series of arrows in Figure 2 leading to and through the nozzle assembly 14.

The nozzle assembly 14 includes a tubular extension 40. A helical mixing vane 42 is provided in the tubular extension 40. Polyurethane constituents flowing through the tubular extension 40 are mixed by the helical mixing vane 42 and are provided to a nozzle tip 46. The nozzle assembly 14 is detachably secured to the mix head 12 by an annular retainer ring 48 that engages a tube receptacle 50. Tube receptacle 50 receives the tubular extension 40 and retains it in a fluid flow relationship with the mixing chamber 30.

Referring to Figure 3, a solvent flush injector 54 is shown spraying a solvent such as methylethylkeytone (MEK) into the mixing chamber 30 to flush and clear polyurethane constituents and the polyurethane mixture from the mixing chamber 30, tubular extension 40, and helical mixing vane 42.

The solvent is purged through the nozzle tip 46 to clear the spray tool apparatus 10.

A polyol supply 56 is illustrated in Figures 2 and 3 that provides polyol to polyol inlet port 58. Polyol inlet port 58 may include a check valve 60 that permits polyol to flow in one direction into the mixing chamber. A polyol outlet port 62 receives polyol from the first channel 26 when the valve piston 24 is in the second position as shown in Figure 3. The polyol outlet port 62 is provided with a check valve 64 that normally permits polyol to flow in one direction out of the spray tool apparatus and return to the polyol supply 56. The spray tool apparatus 10 is shown in its recycling mode in Figure 3 that will be more fully described with reference to Figures 4-6 below.

Referring now to Figures 4-6, the valve piston 24 is shown to include first and second channels 26 and 28. First and second channels 26 and 28 are shown, for example, to be diametrically opposed on opposite sides of the valve piston 24. The first and second channels 26 and 28 provide for recycling of the polyol as previously described and also provide for recycling of isocyanate that is provided through an isocyanate port 68 and is recirculated through isocyanate outletport 70. When the valve piston 24 of the spray tool apparatus 10 is in a position shown in Figure 3, polyol and isocyanate are recycled through the first and second channels 26 and 28 that keep the polyol forming constituents moving and heated toa desired temperature. When the valve piston 24 of the spray tool apparatus 10 is in the first position that is shown in Figure 2, isocyanate and polyol are mixed in the mixing chamber 30 and dispensed through the nozzle assembly 14

and through thenozzle tip 46.

Seals 72, that may be O-ring seals, are retained in annular grooves 74 formed on the valve piston 24 outboard of opposite axial ends of the channels 26 and 28.

Referring to Figure 7, an alternative embodiment of the valve piston76 is shown that may be used to mix a three component mixture comprising isocyanate, polyol, and colored or pigmented polyol. The spray tool apparatus shown in Figure 1 would be provided with three sets of inlet and outlet ports for each of the constituents as previously described. The alternate valve piston 76 has a first channel 78 for the polyol, a second channel 80 for isocyanate, and a third channel 84 for colored, or pigmented, polyol. In this embodiment, operation and function of the spray tool apparatus 10 is substantially the same except that three different constituents are provided to the mix chamber in the first position shown in Figure 2. Three separate flow paths are provided in the recirculating mode so that polyol, isocyanate and pigmented polyol may be separately recirculated in a mannersimilar to the two component recirculation system described above.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the scope of the invention as defined in the accompanying claims.

CLAIMS

1. A spray tool apparatus for spraying polyurethane, comprising:

a plurality of supply sources, each supply source containing one of a plurality polyurethane constituents;

a plurality of recirculating fluid circuits each in fluid flow communication with one of the supply sources for distributing one of the polyurethane constituents;

a mix head connected to each of the fluid circuits that receives from each fluid circuit one of the polyurethane constituents, the mix head having a chamber in which the plurality of polyurethane constituents are mixed to form a polyurethane mixture;

a hydraulically operated valve for controlling the flow of the polyurethane constituents to the mix head, the valve having a first position in whichthe polyurethane constituents flow into the chamber of the mix head and a second position in which the polyurethane constituents are recirculated through the fluid circuits without being mixed in the mixing chamber; and

a spray nozzle assembly through which the polyurethane mixture isdispensed when the valve is in the first position.

2. The apparatus of claim 1 wherein the polyurethane constituents are polyol, isocyanate, and pigmented polyol.

3. The apparatus of claim 1 or 2 wherein the recirculating fluid circuits each have a separate pump for pressurizing one of the polyurethane constituents.

4. The apparatus of any preceding claim further

comprising a liquid solvent supplied to the mix head under pressure to purge the polyurethane mixture from thechamber in the mix head and the spray nozzle assembly when the valve is in the second position.

5. The apparatus of any preceding claim wherein the hydraulically operated valve has a hydraulically actuated piston that is provided with separate channels for each of the polyurethane constituents through which the constituents flow when the valve is in the second position.

6. The apparatus of any preceding claim wherein the hydraulically actuated valve is operated by a hydraulic fluid circuit that has a reciprocating piston that shifts the valve between the first and second positions.

7. The apparatus of any preceding claim wherein the hydraulically actuated valve is operated by a hydraulic fluid circuit that has a reciprocating piston that shifts a valve spool within an elongated chamber, the valve spool and chamber being sealed relative to each other as the valve spool moves between the first and second positions.

8. The apparatus of claim 7 further comprising a seal secured tothe valve spool that seals against the chamber.

9. The apparatus of any preceding claim wherein the spray nozzle assembly has a tubular portion and a static helical mixing vane disposed in the tubular portionthat mixes the polyurethane mixture before the polyurethane mixture is dispensed through a nozzle tip.

10. The apparatus of any preceding claim wherein the mixture of polyurethane is sprayed on a mold to form a polyurethane skin for a vehicle interior part.

11. A method of forming a polyurethane skin for an interior part of a vehicle, comprising:

pumping an isocyanate composition to a mix head;

pumping a polyol composition to the mix head;

opening a valve selectively to allow the polyol composition and the isocyanate composition to be injected under pressure into a mixing chamber definedby the mix head in a first position to create a polyurethane reactant mixture;

closing the valve selectively to allow the polyol composition and isocyanate composition to be recirculated through the valve in a second position;

moving the valve with a hydraulically actuated cylinder that moves a valve element within a valve body between the first position and the second position;

dispensing the polyurethane reactant mixture through a spray nozzle; and

shaping the polyurethane reactant mixture on a mold surface to form a polyurethane skin.

12. The method of claim 11 further comprising mixing the polyurethane reactant mixture with a static helical mixing vane disposed in a tubular portion of the spray nozzle.

13. The method of claim 11 or 12 further comprising spraying a solvent into the mixing chamber when the valve is in the second position to purge the polyurethane reactant mixture from the mixing chamber and the spray nozzle.

14. The method of any one of claims 11 to 13 wherein the valve element further comprises a piston that is provided with a first separate channel for the isocyanate composition and a second separate channel for the polyol composition, wherein eachof the compositions flow through one of the separate channels when the valve is in the second position.

15. A method of forming a polyurethane skin for an interior part of a vehicle, comprising:

pumping an isocyanate composition to a mix head;

pumping a polyol composition to the mix head;

pumping a pigmented polyol composition to the mix head;

opening a valve selectively to allow the polyol composition, the isocyanate composition, and the pigmented polyol to be injected under pressure into a mixing chamber defined by the mix head in a first position to create a pigmented polyurethane reactant mixture;

closing the valve selectively to allow the polyol composition, isocyanate composition, and the pigmented polyol to be recirculated in a second position;

moving the valve with a hydraulically actuated cylinder that moves a valve element within a valve body between the first position and the second position;

dispensing the pigmented polyurethane reactant mixture through a spray nozzle; and

shaping the pigmented polyurethane reactant mixture on a mold surface to form a polyurethane skin.

16. The method of claim 15 further comprising mixing the pigmented polyurethane reactant mixture with a static helical mixing vane disposed in a tubular portion of the spray nozzle.

17. The method of claim 15 or 16 further comprising spraying a solvent into the mixing chamber when the valve is in the second position to purge the pigmented polyurethane reactant mixture from the mixing chamber and the spray nozzle.

18. The method of any one of claims 15 to 17 wherein the valve element further comprises a piston that is provided with a first separate channel for the isocyanate composition, a second separate channel for the polyol composition, and a third separate channel for the pigmented polyol composition, wherein each of the compositions flow through one of the separate channels when the valve is in the second position.

19. A spray tool apparatus substantially as hereinbefore described with reference to, and/or as shown in figures 1 to 7.

20. A method of forming a part substantially as hereinbefore described with reference to, and/or as shown in figures 1 to 7.

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INVESTOR IN PEOPLE

Application No:	GB0507371.3	**Examiner:**	Dr Richard Gregson
Claims searched:	1-20	**Date of search:**	25 July 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,E	1-20	GB 2403449 A (LEAR) - see diagrams, page 3, lines 6-20, page 4, lines 21-24 and pages 7 and 8 in particular.
X	1 at least.	US 4096585 A (FIORENTINI) - see diagrams and columns 3 and 4 in particular.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

B2L

Worldwide search of patent documents classified in the following areas of the IPC^{07}

B05B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI