



- (51) International Patent Classification:
G01B 17/00 (2006.01)
- (21) International Application Number:
PCT/US2012/028388
- (22) International Filing Date:
9 March 2012 (09.03.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/452,699 15 March 2011 (15.03.2011) US
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: RUNNER ASSEMBLY INCLUDING ULTRASONIC TRANSDUCER

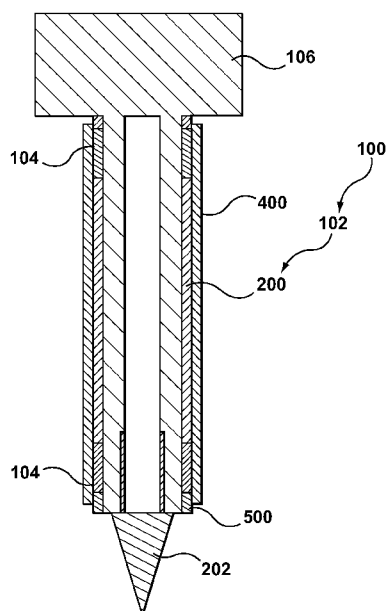


FIG. 2

(57) Abstract: A runner system (100), comprising: a melt-conveying body (102) being configured to convey, in use, a resin; and an ultrasonic transducer (104) being coupled to the melt-conveying body (102), the ultrasonic transducer (104) being configured to measure, in use, a resin parameter being associated with the resin being conveyed in the melt-conveying body (102).

**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

RUNNER ASSEMBLY INCLUDING ULTRASONIC TRANSDUCER

TECHNICAL FIELD

An aspect generally relates to (but is not limited to) a runner system.

SUMMARY

The inventor has researched a problem associated with known molding systems that inadvertently manufacture bad-quality molded articles or parts. After much study, the inventor believes he has arrived at an understanding of the problem and its solution, which are stated below, and the inventor believes this understanding may not be known to the public.

Known injection molding nozzles typically have heaters that are either embedded or attached as a separate component. This is also the case with thermocouples. While these configurations may provide reliable methods for heating and temperature sensing, there are issues associated with this arrangement. These include thermocouple sensing variability due to the installation of the thermocouple itself, and the complexity created by requiring multiple components to be integrated. In addition, these existing systems are limited in their functionality and do not typically have the ability to measure other important parameters such as pressure and flow.

To resolve the above issues at least in part, according to one aspect, there is provided a runner assembly (**100**), comprising: a melt-conveying body (**102**) being configured to convey, in use, a resin; and an ultrasonic transducer (**104**) being coupled to the melt-conveying body (**102**), the ultrasonic transducer (**104**) being configured to measure, in use, a resin parameter being associated with the resin being conveyed in the melt-conveying body (**102**).

Other aspects and features of the non-limiting embodiments will now become apparent to those skilled in the art upon review of the following detailed description of the non-limiting embodiments with the accompanying drawings.

DETAILED DESCRIPTION OF THE DRAWINGS

The non-limiting embodiments will be more fully appreciated by reference to the following detailed description of the non-limiting embodiments when taken in conjunction with the accompanying drawings, in which:

FIGS. 1 and 2 depict schematic representations of a runner system (**100**).

The drawings are not necessarily to scale and may be illustrated by phantom lines, diagrammatic representations and fragmentary views. In certain instances, details not necessary for an understanding of the embodiments (and/or details that render other details difficult to perceive) may have been omitted.

DETAILED DESCRIPTION OF THE NON-LIMITING EMBODIMENT(S)

FIGS. 1 and 2 depict schematic representations of a runner system (**100**). The runner system (**100**) may include components that are known to persons skilled in the art, and these known components will not be described here; these known components are described, at least in part, in the following reference books (for example): (i) "Injection Molding Handbook" authored by OSSWALD/TURNIG/GRAMANN (ISBN: 3-446-21669-2), (ii) "Injection Molding Handbook" authored by ROSATO AND ROSATO (ISBN: 0-412-99381-3), (iii) "Injection Molding Systems" 3rd Edition authored by JOHANNABER (ISBN 3-446-17733-7) and/or (iv) "Runner and Gating Design Handbook" authored by BEAUMONT (ISBN 1-446-22672-9). It will be appreciated that for the purposes of this document, the phrase "includes (but is not limited to)" is equivalent to the word "comprising." The word "comprising" is a transitional phrase or word that links the preamble of a patent claim to the specific elements set forth in the claim that define what the invention itself actually is. The transitional phrase acts as a limitation on the claim, indicating whether a similar device, method, or composition infringes the patent if the accused device (etc) contains more or fewer elements than the claim in the patent. The word "comprising" is to be treated as an open transition, which is the broadest form of transition, as it does not limit the preamble to whatever elements are identified in the claim.

The definition of the runner system (**100**) is as follows: a system that may be positioned and/or may be used in an envelope defined by a platen system of a molding system, such as an injection-molding system for example. The platen system may include a stationary

platen and a movable platen that is moveable relative to the stationary platen. The molding system may have the runner system (100).

Referring now to FIG. 1, in which the runner system (100) that is depicted may include (and is not limited to): (i) a melt-conveying body (102), and (ii) an ultrasonic transducer (104).

The melt-conveying body (102) may be configured to convey, in use, a resin. The ultrasonic transducer (104) may be coupled to the melt-conveying body (102). More specifically, the ultrasonic transducer (104) may be coupled to an outer surface of the melt-conveying body (102). In addition, the ultrasonic transducer (104) may be embedded, at least in part, in the melt-conveying body (102). The ultrasonic transducer (104) may be configured to measure, in use, a resin parameter being associated with the resin being conveyed in the melt-conveying body (102). By way of example, the resin parameter to be measured by the ultrasonic transducer (104) may include an amount of resin pressure and/or an amount of resin flow.

By way of example, the ultrasonic transducer (104) may include (and is not limited to) an ultrasonic emitter and an ultrasonic receiver. The ultrasonic emitter may be powered by an associated ultrasound-signal generator. The ultrasonic transducer (104), may be also called an ultrasonic sensor. The ultrasonic transducer (104) may also be called a transceiver when the ultrasonic transducer (104) is configured to both send and receive. The ultrasonic transducer (104) operates on a principle similar to radar or sonar, which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. The ultrasonic transducer (104) may be configured to generate, in use, high frequency sound waves, and to evaluate an echo that is received back by the ultrasonic transducer (104).

The ultrasonic transducer (104) may also be configured to calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. The ultrasonic transducer (104) may use a transducer that generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy, which can be measured and displayed.

An example of the melt-conveying body (102) is depicted in FIG. 1, in which the melt-conveying body (102) may include (and is not limited to) a nozzle body (200) having a nozzle tip (202) connected to an output of the nozzle body (200). The nozzle body (200) may be configured for connection with a manifold assembly (106) of the runner system

(100). Another example of the melt-conveying body (102) may include (and is not limited to) is a sprue assembly (not depicted). The sprue assembly is an assembly that connects a melt-preparation system (not depicted, such as an extruder) to the manifold assembly (106). It will also be appreciated that the melt-conveying body (102) may include the manifold assembly (106).

The runner system (100) may further include (and is not limited to) a heating element (400) that may be coupled to the melt-conveying body (102). In addition, the runner system (100) may further include (and is not limited to) a temperature sensor (500) that may be coupled to the melt-conveying body (102). The temperature sensor (500) may be positioned relative to the heating element (400).

According to the example depicted in FIG. 1, the heating element (400) and the temperature sensor (500) may be positioned in an adjacent arrangement relative to each other.

According to an option, the runner system (100) may further include (and is not limited to) a computer system (300) that may be configured to connect with the ultrasonic transducer (104), and also configured to monitor an output signal of the ultrasonic transducer (104).

The computer system (300) that may also be configured to connect with the heating element (400), and also configured to control the heating element (400) based on a comparison made between: (i) the signal received, in use, from the ultrasonic transducer (104), and (ii) a threshold level.

Turning now to FIG. 2, there is depicted another example of the runner system (100), in which the heating element (400) and the temperature sensor (500) may be positioned in a layered arrangement relative to each other.

The runner system (100) may provide integrated heating and temperature sensing portions of the melt-conveying body (102), and may add an additional capability to determine characteristics related to pressure and flow rates (of the resin) as well without compromising structural integrity of the melt-conveying body (102) as is associated with known pressure or flow sensors.

The runner system (100) may provide the melt-conveying body (102) with the heating element (400) that may be integrated with the melt-conveying body (102). The runner system (100) may provide the melt-conveying body (102) with the temperature sensor (500) that may be integrated with the melt-conveying body (102). The runner system (100) may provide the melt-conveying body (102) with the ultrasonic transducer (104) that may be integrated with the melt-conveying body (102). By utilizing multiple pressure inferring measurement sensors or devices spaced out toward the ends of the melt-conveying body (102), flow rates through the melt-conveying body (102) may also be inferred, especially for the case where multiple instances of the melt-conveying body (102) is used (such as multiple instances of the nozzle body (200)). By being able to measure the temperature at one or more locations within the melt-conveying body (102), as well as being able to infer variability in pressure drop and flow rates amongst a group of or a collection of the melt-conveying body (102), significant advantages may be obtained. Processes may be controlled to a higher degree, process monitoring may be increased to allow for recording and verification of information that has previously been extremely difficult to obtain, and system balance may be measured and/or controlled to provide an increased level of system performance.

The heating element (400) may be integrated to the melt-conveying body (102). The heating element (400) may be applied to the melt-conveying body (102) by using numerous processes including (and not limited to): thermal spray based resistive heating, thick film based resistive heating, or sol-gel based heating. The heating element (400) may be applied directly to the melt-conveying body (102) and may be created with a watt distribution profile (heat profile) that may be suited for each application. Heater zones may be controlled either together or individually for increased performance.

The temperature sensor (500) may be integrated with the melt-conveying body (102). The temperature sensor (500) may include (and is not limited to) thermocouples, thermistors that may be directly applied to the melt-conveying body (102) as well. Again, methods of manufacturing the temperature sensor (500) may include thermal spray, film deposition (PVD, CVD), or solvent based printing. These methods may be used to produce thermocouple junctions at desired points along the length of the nozzle, including under or on top of the heating elements.

The ultrasonic transducer (104) may provide pressure sensing measurements. As well, the ultrasonic transducer (104) may be integrated with the melt-conveying body (102). The ultrasonic transducer (104) may be applied to the outer diameter of the melt-conveying body (102). The ultrasonic transducer (104) may be used to measure the speed of sound of the resin flowing through the melt-conveying body (102). The speed of sound within the melt-conveying body (102) is directly related to the density and temperature of the medium within the melt-conveying body (102). Therefore, the ultrasonic transducer (104) may be used to infer the pressure and monitor pressure changes within the melt-conveying body (102). Additionally, flow rates within the melt-conveying body (102) may be related to the pressure differential along a length of the melt-conveying body (102). Therefore, utilizing two or more ultrasonic transducers (104) along the length of the melt-conveying body (102) may give information regarding the flow rate of the resin along the melt-conveying body (102). This may be achievable without compromising the structural integrity of the melt-conveying body (102) as the ultrasonic transducer (104) may be created on the outside of the outer diameter of the melt-conveying body (102). The pressure and flow rate information may be recorded for process monitoring (by way of the computer system (300)), or may be also be used to tune the process in terms of balance of the runner system (100). As with the temperature transducers explained above, the ultrasonic transducer (104) may be applied above or below either of the heating element (400) and the temperature sensor (500). This arrangement may allow for the ability to infer pressure, flow, and temperature at multiple locations along the length of the melt-conveying body (102) while still being able to supply heat from the heating element (400) along the full length of the melt-conveying body (102) if so desired. The heating element (400), the temperature sensor (500) and the ultrasonic transducer (104) may be oriented or positioned in such a way that they are adjacent each other on the outer surface of the melt-conveying body (102) as compared to layered atop each other.

The heating element (400), the temperature sensor (500), and the ultrasonic transducer (104) may be combined in various configurations for the desired sensing and control locations as well as the desired heat input locations (this includes both the placement and layering of the components). In addition, the melt-conveying body (102) may have one or more of each of the heating element (400), the temperature sensor (500), and the ultrasonic transducer (104) to provide the desired performance of heating, temperature sensing element, and ultrasonic sensing. Each of the heating element (400), the temperature sensor (500), and the ultrasonic transducer (104) may have integrated

connectors to allow for easy installation of the melt-conveying body (102) in the runner system (100). Additional components may be included as well, such as protective outer sleeves, etc. It is noted that the heating element (400), the temperature sensor (500), and the ultrasonic transducer (104) may be used to perform similarly with the manifold assembly (106).

ADDITIONAL DESCRIPTION

The following clauses are offered as further description of the aspects of the present invention. Clause (1): a runner system (100), comprising: a melt-conveying body (102) being configured to convey, in use, a resin; and an ultrasonic transducer (104) being coupled to the melt-conveying body (102), the ultrasonic transducer (104) being configured to measure, in use, a resin parameter being associated with the resin being conveyed in the melt-conveying body (102). Clause (2): the runner system (100) of clause (1), wherein: the melt-conveying body (102) includes a nozzle body (200). Clause (3): the runner system (100) of any clause mentioned in this paragraph, wherein: the melt-conveying body (102) includes a sprue. Clause (4): the runner system (100) of any clause mentioned in this paragraph, wherein: the melt-conveying body (102) includes a manifold assembly (106). Clause (5): the runner system (100) of any clause mentioned in this paragraph, wherein: the resin parameter includes an amount of resin pressure. Clause (6): the runner system (100) of any clause mentioned in this paragraph, wherein: the resin parameter includes an amount of resin flow. Clause (7): the runner system (100) of any clause mentioned in this paragraph, further comprising: a heating element (400) being coupled to the melt-conveying body (102). Clause (8): the runner system (100) of any clause mentioned in this paragraph, further comprising: a temperature sensor (500) being coupled to the melt-conveying body (102). Clause (9): the runner system (100) of any clause mentioned in this paragraph, further comprising: a heating element (400) being coupled to the melt-conveying body (102); and a temperature sensor (500) being positioned relative to the heating element (400). Clause (10): the runner system (100) of any clause mentioned in this paragraph, wherein: the heating element (400) and the temperature sensor (500) are positioned in a layered arrangement relative to each other. Clause (11): the runner system (100) of any clause mentioned in this paragraph, wherein: the heating element (400) and the temperature sensor (500) are positioned in an adjacent arrangement relative to each other. Clause (12): the runner system (100) of any clause mentioned in this paragraph, further comprising: a computer system (300) being configured to: connect with the ultrasonic

transducer (104): and monitor an output signal of the ultrasonic transducer (104). Clause (13): the runner system (100) of any clause mentioned in this paragraph, further comprising: a computer system (300) being configured to: connect with the ultrasonic transducer (104); monitor an output signal of the ultrasonic transducer (104); connect with the heating element (400); and control the heating element (400) based on a comparison made between: (i) a signal received, in use, from the ultrasonic transducer (104), and (ii) a threshold level. Clause (14): a molding system having the runner system (100) of any clause mentioned in this paragraph.

It will be appreciated that the assemblies and modules described above may be connected with each other as may be required to perform desired functions and tasks that are within the scope of persons of skill in the art to make such combinations and permutations without having to describe each and every one of them in explicit terms. There is no particular assembly, components, or software code that is superior to any of the equivalents available to the art. There is no particular mode of practicing the inventions and/or examples of the invention that is superior to others, so long as the functions may be performed. It is believed that all the crucial aspects of the invention have been provided in this document. It is understood that the scope of the present invention is limited to the scope provided by the independent claim(s), and it is also understood that the scope of the present invention is not limited to: (i) the dependent claims, (ii) the detailed description of the non-limiting embodiments, (iii) the summary, (iv) the abstract, and/or (v) description provided outside of this document (that is, outside of the instant application as filed, as prosecuted, and/or as granted). It is understood, for the purposes of this document, the phrase "includes (and is not limited to)" is equivalent to the word "comprising." It is noted that the foregoing has outlined the non-limiting embodiments (examples). The description is made for particular non-limiting embodiments (examples). It is understood that the non-limiting embodiments are merely illustrative as examples.

CLAIMS**WHAT IS CLAIMED IS:**

- 5 1. A runner system (**100**), comprising:
a melt-conveying body (**102**) being configured to convey, in use, a resin; and
an ultrasonic transducer (**104**) being coupled to the melt-conveying body
(**102**), the ultrasonic transducer (**104**) being configured to measure, in use, a resin
parameter being associated with the resin being conveyed in the melt-conveying
10 body (**102**).
2. The runner system (**100**) of any preceding claim, wherein:
the melt-conveying body (**102**) includes a nozzle body (**200**).
- 15 3. The runner system (**100**) of any preceding claim, wherein:
the melt-conveying body (**102**) includes a sprue.
4. The runner system (**100**) of any preceding claim, wherein:
the melt-conveying body (**102**) includes a manifold assembly (**106**).
- 20 5. The runner system (**100**) of any preceding claim, wherein:
the resin parameter includes an amount of resin pressure.
6. The runner system (**100**) of any preceding claim, wherein:
25 the resin parameter includes an amount of resin flow.
7. The runner system (**100**) of any preceding claim, further comprising:
a heating element (**400**) being coupled to the melt-conveying body (**102**).
- 30 8. The runner system (**100**) of any preceding claim, further comprising:
a temperature sensor (**500**) being coupled to the melt-conveying body (**102**).
9. The runner system (**100**) of any preceding claim, further comprising:
a heating element (**400**) being coupled to the melt-conveying body (**102**); and

a temperature sensor (500) being positioned relative to the heating element (400).

10. The runner system (100) of any preceding claim, wherein:

5 the heating element (400) and the temperature sensor (500) are positioned in a layered arrangement relative to each other.

11. The runner system (100) of any preceding claim, wherein:

10 the heating element (400) and the temperature sensor (500) are positioned in an adjacent arrangement relative to each other.

12. The runner system (100) of any preceding claim, further comprising:

 a computer system (300) being configured to:
 connect with the ultrasonic transducer (104); and
15 monitor an output signal of the ultrasonic transducer (104).

13. The runner system (100) of any preceding claim, further comprising:

 a computer system (300) being configured to:
 connect with the ultrasonic transducer (104);
20 monitor an output signal of the ultrasonic transducer (104);
 connect with the heating element (400); and
 control the heating element (400) based on a comparison made
 between: (i) a signal received, in use, from the ultrasonic transducer (104),
 and (ii) a threshold level.

25 14. A molding system having the runner system (100) of any preceding claim.

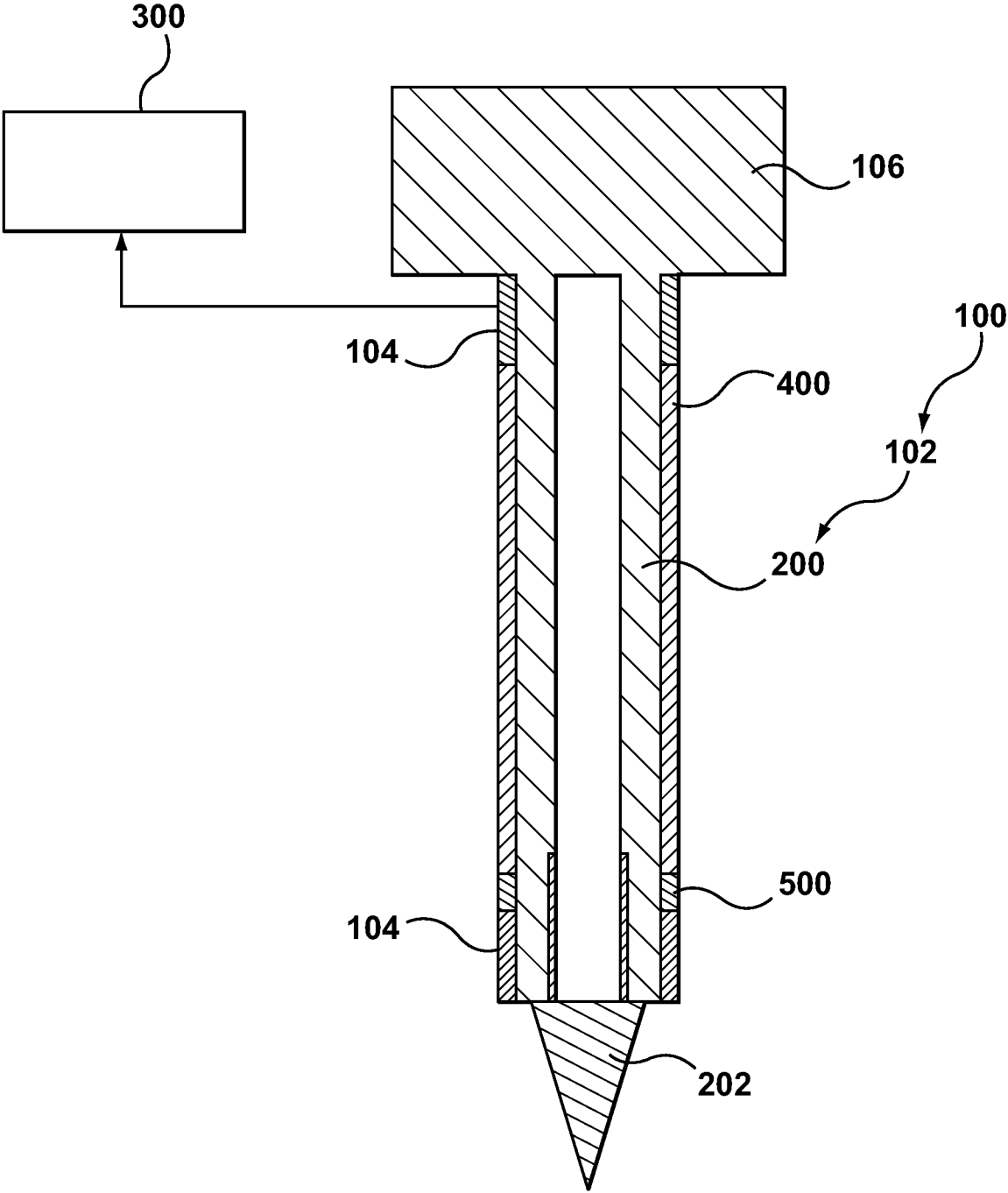


FIG. 1

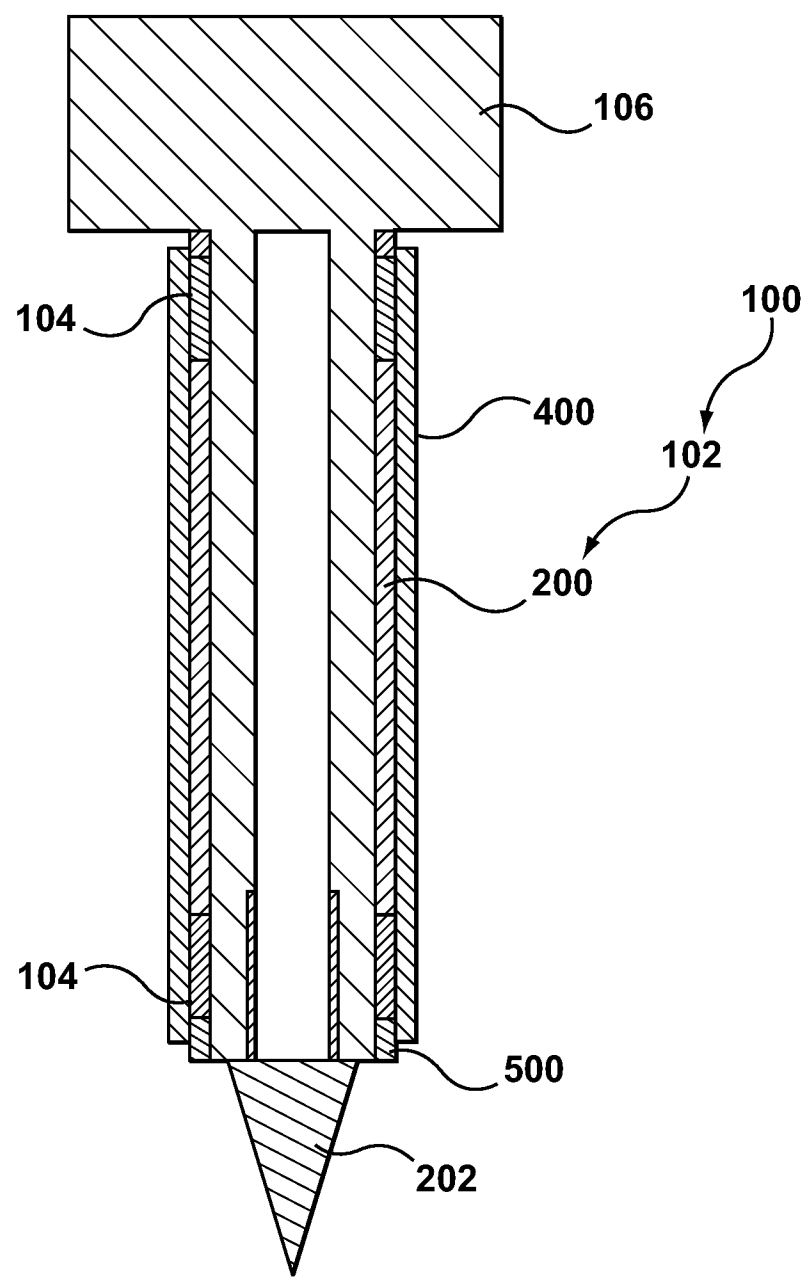


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28388

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G01B 17/00 (2012.01)

USPC - 264/407

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

USPC: 264/407

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC: 73/1.82, 1.83, 861.18; 264/406, 407 (text search - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PubWEST(USPT,PGPB,EPAB,JPAB); Google

Search Terms: runner, ultrasonic, sensor, detector, nozzle, resin, thermoplastic, flow, pressure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/0206991 A1 (GODWIN et al.) 06 November 2003 (06.11.2003), entire document especially Fig 9; paras [0071]-[0072], [0091], [0097]	1-3
Y	FONSECA et al., A Critical Overview of Sensors for Monitoring Polymerizations, Article [online] December 2009 (12.2009) [retrieved on 06 June 2012 (06.06.2012)]. Retrieved from the Internet: <URL: http://193.146.160.29/gtb/sod/usu/\$UBUG/repositorio/10300325_Fonseca.pdf > pgs 329, 353	1-3
A	US 2009/0315205 A1 (KOUMARY) 24 December 2009 (24.12.2009), entire document	1-3

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

05 June 2012 (05.06.2012)

Date of mailing of the international search report

22 JUN 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents

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Authorized officer:

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PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28388

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 4-14
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.