



(51) International Patent Classification:
B29C 45/18 (2006.01)

(21) International Application Number:
PCT/US2012/028387

(22) International Filing Date:
9 March 2012 (09.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/452,773 15 March 2011 (15.03.2011) US

(71) Applicant (for all designated States except US): **HUSKY INJECTION MOLDING SYSTEMS LTD** [CA/CA];
500 Queen Street South, Bolton, Ontario L7E 5S5 (CA).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **ESSER, Brian** [US/US]; 151 Broadlake Road, Colchester, Vermont 05446 (US).

(74) Agent: **MUSGRAVE, Richard J.**; 288 North Road, Milton, Vermont 05468 (US).

(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).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) Title: MOLD-TOOL SYSTEM INCLUDING ACTUATION SYSTEM

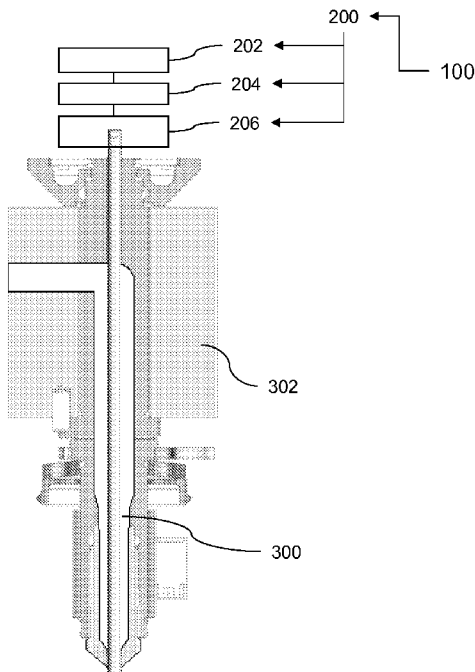


FIG. 2

(57) Abstract: A mold-tool system (100), comprising: an actuation system (200), including: an electric motor (202) being configured to convert electrical energy to mechanical rotational energy; a torque-amplifying device (204) being coupled to the electric motor (202), and being configured to provide a speed-torque varying component of the mechanical rotational energy associated with the electric motor (202); and a conversion assembly (206) being coupled with the torque-amplifying device (204), the conversion assembly (206) being configured to convert rotational motion of the torque-amplifying device (204) to a linear motion.

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

MOLD-TOOL SYSTEM INCLUDING ACTUATION SYSTEM

TECHNICAL FIELD

An aspect generally relates to (but is not limited to) molding systems, including (but not limited to) a mold-tool 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 that this understanding may not be known to the public.

Electrical actuation methods have a certain energy density that is they can only provide so much force and speed. An increase in speed results in a corresponding decrease in force. Fixed systems must be set to deliver a compromise of maximum force and speed, resulting in a system that is optimized for neither attribute.

By incorporating a system which adjusts the force-speed output of the electrical actuator (either automatically or through external control), the valve stem can move as fast as possible with the given force requirements. This will results in a smaller actuator for a given set of force-speed requirements and perhaps enable solutions that are otherwise not feasible. In addition, a single type of system could be used on a wide variety of applications as the system compensates for increased force requirements and thus would work well for both low force high speed applications as well as slower, higher force applications.

According to one aspect, there is provided a mold-tool system (100), comprising: an actuation system (200), including: an electric motor (202) being configured to convert electrical energy to mechanical rotational energy; a torque-amplifying device (204) being coupled to the electric motor (202), and being configured to provide a speed-torque varying component of the mechanical rotational energy associated with the electric motor (202); and a conversion assembly (206) being coupled with the torque-amplifying device (204), the conversion assembly (206) being configured to convert rotational motion of the torque-amplifying device (204) to a linear motion.

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.

5 **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:

10 FIGS. 1 and 2 depict schematic representations of a mold-tool 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
15 difficult to perceive) may have been omitted.

DETAILED DESCRIPTION OF THE NON-LIMITING EMBODIMENT(S)

FIGS. 1 and 2 depict schematic representations of a mold-tool system (**100**). It will be appreciated that for the purposes of this document, the phrase “includes (but is not limited
20 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
25 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 mold-tool system (**100**) is as follows: (i) a system that may be
30 positioned and/or may be used in an envelope defined by a platen system (not depicted) of the molding system (not depicted), 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, and/or (ii) a system that may be positioned and/or may be used in outside of an envelope defined by the platen system of the molding system.

35

Referring to FIG. 1, the mold-tool system (100) may include (and is not limited to) an actuation system (200). The actuation system (200) may include (and is not limited to): (i) an electric motor (202), (ii) a torque-amplifying device (204), and (iii) a conversion assembly (206). The electric motor (202) may be configured to convert electrical energy to mechanical rotational energy. The torque-amplifying device (204) may be coupled to the electric motor (202). The torque-amplifying device (204) may be configured to provide a speed-torque varying component of the mechanical rotational energy associated with the electric motor (202). The conversion assembly (206) may be coupled with the torque-amplifying device (204). The conversion assembly (206) may be configured to convert rotational motion of the torque-amplifying device (204) to a linear motion.

Referring now to FIG. 2, the mold-tool system (100) may be adapted such that the conversion assembly (206) may be connected to valve stem (300) of a runner assembly (302), and the conversion assembly (206) may be configured to linearly move the valve stem (300).

It will be appreciated that the runner assembly (302) may have the mold-tool system (100). It may also be appreciated that the molding system may have the mold-tool system (100). Examples of the electric motor (202) may include and is not limited to: (i) a direct current motor, (ii) a permanent magnet motor, (iii) a universal motor, (iv) an alternating current (AC) motor. Examples of the torque-amplifying device (204) may include (and is not limited to): (i) a gearbox assembly, (ii) a planetary-gear reduction assembly, (iii) a viscous-torque converter, (iv) a continuously-variable transmission (CVT). Examples of the continuously-variable transmission (CVT) may include (and is not limited to): (i) a friction-drive assembly, (ii) a positive-drive assembly, (iii) a chain assembly, a belt assembly, a gear assembly, a toroidal-based assembly, and a roller-based assembly. Examples of the rotational to linear motion conversion assembly (206) may include (and is not limited to): (i) a ball screw actuator, (ii) a lead screw actuator, (iii) a rack and pinion assembly, (iv) a worm drive assembly.

The actuation system (200) may be configured to adjust a force-speed output of the electric motor (202) to provide an optimized output. This arrangement may be accomplished through numerous assemblies including but not limited to fluid couplings, planetary gear sets, clutches, etc.

The actuation system (200) may be configured to adjust a force-speed output automatically, or may include an actuation means. The actuation system (200) may move as fast as possible during an initial closing of the valve stem (300), then slow down with a corresponding increase of output force/torque as the valve stem (300) becomes more difficult to move as the valve stem (300) displaces more or higher pressure resin. For the case of opening the valve stem (300), the valve stem (300) may be moved very quickly as the force requirements for this case may be correspondingly low.

A fluid coupling may act similar to a torque converter in an automatic automotive transmission. When a resistance (force) is low, the output may match a speed of the input. When the force requirements increase, the fluid coupling may allow slippage of the input relative to the output, but may provide an increase in output torque through the fluid shear forces acting on the output. This arrangement may also prevent damage to the electric motor (202) for the case of excessive force as the fluid coupling may allow the actuation system (200) to continue to move without requiring any movement of the output.

A planetary assembly may rely on a planetary gear set, which may operate in a direct drive mode, a planetary-reduction mode, or a combination of the two modes to provide the required motion. For the case where the force requirements are low, the input speed may match the output speed and the planetary drive may rotate as well. When the force requirements increased, the planetary drive may slow its spinning, resulting in a torque amplification as the internal gears begin to spin, so that the actuation system (200), may self compensate to deliver the maximum speed for the given force requirements.

Other methods to create this force compensating valve actuation may include a continuously-variable transmission (CVT), in which the force automatically increases as the rotational speed decreases (and vice-versa). Another example may include an automatic transmission style actuation where the speed and load on the output shaft determine the gear set used for that particular portion of the stroke. Other methods to accomplish this force-speed compensation may include slipper clutches, or combinations of the above examples. In addition, other power transmission devices may be used in conjunction with the force compensating device to provide the required motion, such as worm drives, rack and pinions, etc.

As mentioned above, the actuation system (200) may automatically compensate for the requirements (similar to that of a differential or torque converter), or have active actuation. Active actuation may use a variety of actuation assemblies, such as electrical engagement actuators to change parameters (i.e., engage or disengage direct drive versus reduced speed torque amplification), active fluid coupling using magneto-rheological fluids, or other means. Feedback of the position of valve stem (300) may also be used to control the position of the valve stem (300) as a function of time to provide profiled actuation, within the capabilities of the system's speed-force properties. While the most attractive implementation of the actuation system (200) uses an electrical actuator to create the motion, the actuation system (200) may be used on or with a valve stem (300) that may be pneumatically or hydraulically actuated.

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 mold-tool system (**100**), comprising:
a movable element (299) being configured to move linearly; and
an actuation system (**200**) being connected to the movable element (299) the
actuation system (200) being configured to:
- 10 (i) convert electrical energy to mechanical rotational energy;
(ii) provide a speed-torque varying component of the mechanical rotational
energy; and
(iii) convert rotational motion associated with the speed-torque varying
component to a linear motion.
- 15 2. The mold-tool system (**100**) of claim 1, wherein:
actuation system (**200**) includes:
an electric motor (**202**) being configured to convert electrical energy to
mechanical rotational energy;
a torque-amplifying device (**204**) being coupled to the electric motor (**202**), and
20 being configured to provide a speed-torque varying component of the mechanical
rotational energy associated with the electric motor (**202**); and
a conversion assembly (**206**) being coupled with the torque-amplifying device
(**204**), the conversion assembly (**206**) being configured to convert rotational motion of
the torque-amplifying device (**204**) to a linear motion.
- 25 2. The mold-tool system (**100**) of claim 1, wherein:
the conversion assembly (**206**) is connected to valve stem (**300**) of a runner
assembly (**302**), the conversion assembly (**206**) is configured to linearly move the
valve stem (**300**).
- 30 3. A runner assembly (**302**) having the mold-tool system (**100**) of claim 1.
4. A molding system having the mold-tool system (**100**) of any preceding claim.

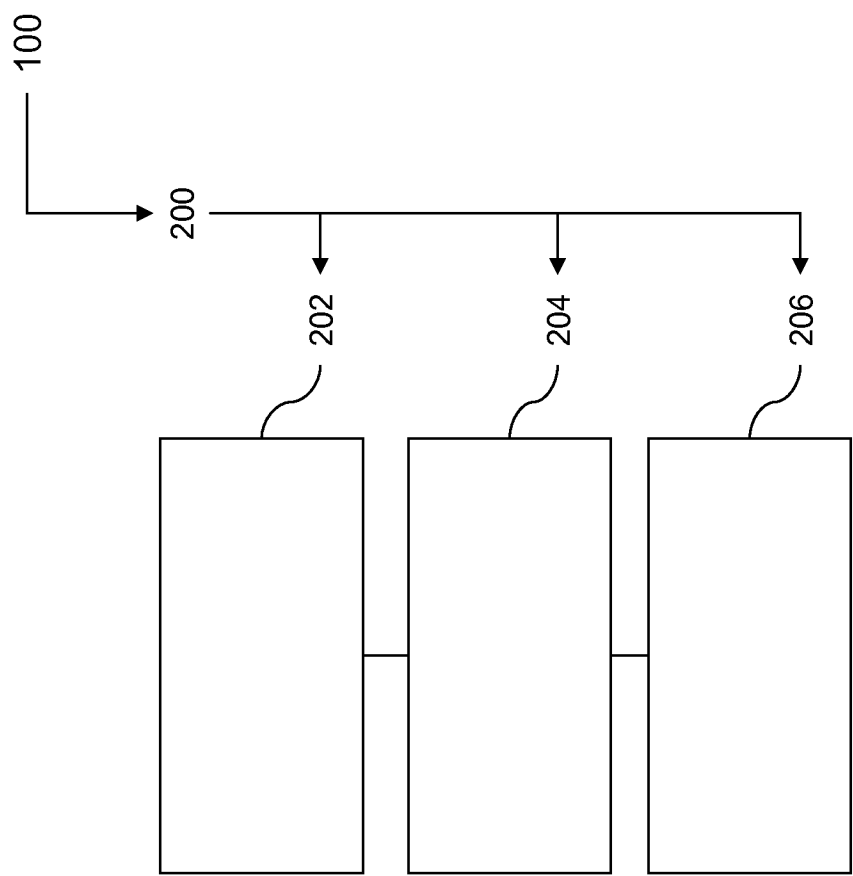


FIG. 1

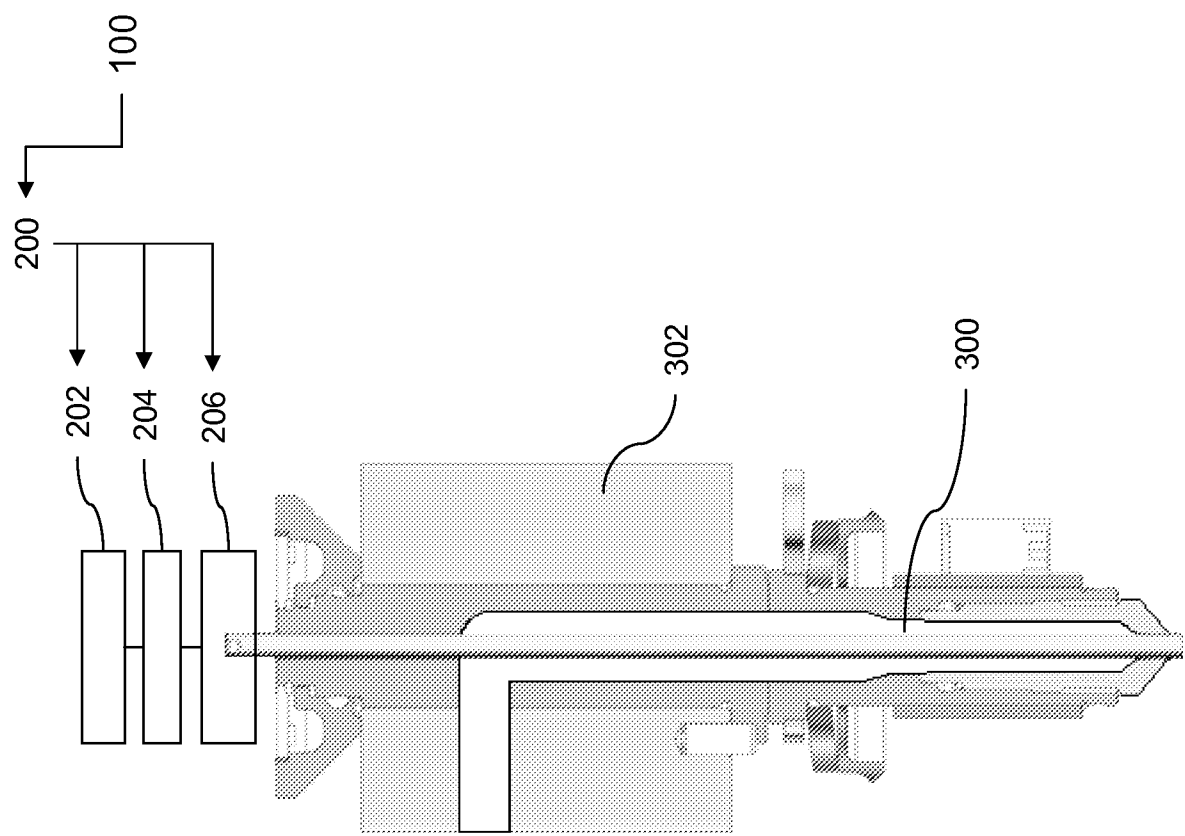


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28387

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B29C 45/18 (2012.01)

USPC - 425/562

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 - 425/562Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 264/40.1, 40.7;
425/145, 564, DIG224, DIG229

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

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

mold tool lead screw valve actuation gear reduction transmission worm drive electric motor pin torque converter hot runner load adjust
stem gearbox linear rotary actuation system planetary pressure feedback

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 7,828,540 B2 (Dantlgraber) 09 November 2010 (09.11.2010) (Col. 4, ln 25-24; Col. 4, ln 36-50; Fig 2)	1-2a, 3-4
Y	US 4,213,751 A (Fernandez) 22 July 1980 (22.07.1980) (Col. 2, ln 25-40)	2b

☐

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

21 June 2012 (21.06.2012)

Date of mailing of the international search report

27 JUN 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774