UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON AT SEATTLE

FANTASIA TRADING, LLC D/B/A ANKERDIRECT, Plaintiff, v. SLICE ENGINEERING LLC, Defendant.	NO. 2:23-cv-01436 **COMPLAINT FOR DECLARATORY JUDGMENT**

Plaintiff Fantasia Trading, LLC d/b/a AnkerDirect ("AnkerDirect" or "Plaintiff") files this Complaint for Declaratory Judgment against Slice Engineering LLC ("Slice" or "Defendant") and alleges as follows:

NATURE OF THE ACTION

1. This is an action for a declaratory judgment of noninfringement and invalidity arising under the patent laws of the United States, Title 35 of the United States Code.

2. Defendant Slice purports to be the owner of U.S. Patent No. 11,660,810 (the "'810 patent" or "the Asserted Patent") (attached as Exhibit A).

3. Slice's actions and statements, including its allegations of infringement of the '810 patent by AnkerDirect as detailed below, have created a real and substantial controversy

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that warrants issuance of a declaratory judgment of invalidity of the '810 patent and/or of noninfringement by Plaintiffs of the '810 patent.

4. This Court should not allow the imminent threat of a lawsuit to harm and cause uncertainty to Plaintiff's business.

JURISDICTION AND VENUE

5. The Court has subject matter jurisdiction over this action pursuant to 28 U.S.C. §§ 1331 and 1338(a) because this action involves claims arising under the patent laws of the United States, 35 U.S.C. § 1, et seq., and under the Federal Declaratory Judgment Act, 28 U.S.C. §§ 2201 and 2202.

6. Personal jurisdiction is proper in this Court because Slice has purposefully directed activities at residents of this District and the State of Washington, and the claims herein arise out of and relate to those activities, such that personal jurisdiction in this case is reasonable and fair.

7. Venue is proper in this Court pursuant to 28 U.S.C. §§ 1391(b) and 1391(c)(2) because a substantial part of the events giving rise to the claims occurred in this District and because Defendant is subject to personal jurisdiction in this District.

8. For the reasons set forth below, a substantial controversy exists between the parties which is of sufficient immediacy and reality to warrant declaratory relief.

BACKGROUND

9. Plaintiff Fantasia Trading, LLC d/b/a AnkerDirect is a Delaware corporation with its principal place of business at 5350 Ontario Mills Parkway, Suite 100, Ontario, California 91764.

10. The Anker family of companies (collectively, "Anker") is a global consumer electronics company that specializes in developing mobile charging accessories and home energy solutions, as well as unique consumer products that support premium audio, mobile entertainment, and the emerging smart home space.

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11. Anker is an innovator that does not and need not copy the designs of others. In 2018 and 2019, Anker won Amazon's Global Open Store Seller of the Year Award two years in a row. Anker has always prioritized quality in building its brand, and over time it has steadily increased its R&D investments. In this work, Anker focuses on providing better products and experiences to users. Anker stands behind its products and has built a customer service team to provide consumers with 18 months of after-sales protection. Today, Anker has over 140 million customers in more than 140 countries and regions globally. Anker respects the intellectual property rights of others. And Anker is active in protecting its own intellectual property rights. At present, Anker has filed more than 3,000 patent applications worldwide, and holds more than 1,200 issued patents.

12. AnkerDirect sells the AnkerMake M5C 3-D printer ("the Accused Product") in this District and throughout the US via listings on Amazon.com.

13. Defendant Slice is a limited liability company organized under the laws of the State of Florida, with its headquarters located at 747 SW Second Avenue, Suite 296, Gainesville, Florida 32601. On information and belief, Slice is the owner by assignment of the '810 patent.

14. The '810 patent is entitled "Adaptable High-Performance Extrusion Head for Fused Filament Fabrication Systems." The '810 patent bears an issuance date of May 30, 2023. Fused filament fabrication systems are commonly referred to as 3-D printers.

15. On information and belief, Slice sells various products related to 3-D printers, including products purporting to practice the '810 patent, by listings on Amazon.com.

16. On information and belief, sometime prior to August 24, 2023, Slice sent communications to Amazon.com in Washington claiming that the Accused Product infringes the '810 patent and requesting that Amazon.com remove three ASIN listings for the Accused Product. On information and belief, Slice requested to use Amazon's APEX Patent Evaluation process to address its claim of infringement.

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17. On or about August 24, 2023, AnkerDirect received an email from Amazon.com stating that it had received a report from Slice claiming that the Accused Product infringes the '810 patent. (A copy of the email is attached as Exhibit B.) The Amazon.com email stated that Amazon.com would remove listings for the Accused Product unless, *inter alia*, AnkerDirect agreed to participate in the Amazon APEX process or AnkerDirect filed an action for declaratory judgment of non-infringement of the asserted patent within three weeks.

18. Removal of the Amazon.com listings for the Accused Product threatens to cause substantial harm to AnkerDirect's business selling the Accused Product. A substantial share of the Accused Product's sales are made through orders received on Amazon.com.

COUNT I: DECLARATION OF NONINFRINGEMENT

19. Plaintiff repeats and realleges the allegations in paragraphs 1–18 as though fully set forth herein.

20. AnkerDirect has not infringed and does not infringe, directly or indirectly, any valid and enforceable claim of the '810 Patent. Claim 1 of the '810 Patent recites:

> "a cooler thermally coupled with the upstream portion for reducing upstream heat transfer, the cooler spaced generally axially upstream from the heater; and
> a generally axially extending gap, bound by a bridge traversing the gap between the cooler and the heater; wherein,
> …;
> the bridge … comprises:
> a first structural component … having a first portion bearing against the heater and a second portion bearing against the cooler…; and
> a second structural component … having a first portion bearing against the heater and a second portion bearing against the cooler ."

21. The Accused Product does not comprise "a cooler … spaced generally axially upstream from the heater" as described in the specification and shown in the drawings of the '810 Patent.

22. The Accused Product does not comprise "a generally axially extending gap, bound by a bridge traversing the gap between the cooler and the heater" as described in the specification and shown in the drawings of the '810 Patent.

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23. The Accused Product does not comprise a bridge with a "first structural component . . . having a first portion bearing against the heater" as described in the specification and shown in the drawings of the '810 Patent.

24. AnkerDirect is entitled to a declaratory judgment that it has not infringed and is not infringing the '810 Patent.

COUNT II: DECLARATION OF INVALIDITY

25. Plaintiff repeats and realleges the allegations in paragraphs 1–24 as though fully set forth herein.

26. The '810 Patent is invalid for failure to meet the conditions of patentability and/or otherwise to comply with one or more of 35 U.S.C. §§ 100 et seq., 101, 102, 103, 112 and 132.

27. Claims 1-3, 12-14, 19-20 are invalid under 35 U.S.C. §102(a)(1) as being anticipated by Wolf et al (US 2016/0236408, filed on Jul. 23, 2014).

28. Independent Claim 1 and dependent Claims 2-20 are invalid under 35 U.S.C. § 103 as obvious in view of Wolf in combination with the knowledge of one of ordinary skill in the art and/or other prior art publications, including but not limited to Espalin et al (US 2017/0064840, filed on Aug. 24, 2015), Batchelder et al (US 2017/0217089, filed on Sep. 26, 2014), Neboian et al (US 2019/0118467, filed on May 6, 2015), and Sydow et al (US 2019/0184633, filed on Apr. 11, 2016).

29. AnkerDirect is entitled to a declaratory judgment that '810 Patent is invalid.

PRAYER FOR RELIEF

WHEREFORE, AnkerDirect respectfully requests that judgment be entered:

a. Declaring that AnkerDirect has not and does not infringe, directly, contributorily, by inducement, literally or by equivalents, jointly, or willfully, any claim of the '810 Patent by making, using, selling, offering to sell, and/or importing of the Accused Product;

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b. Declaring that the Accused Product does not infringe, directly, contributorily, by inducement, literally or by equivalents, jointly, or willfully, any claim of the '810 Patent;

c. Declaring that the '810 Patent is invalid for failure to meet the conditions of patentability and/or otherwise to comply with one or more of 35 U.S.C. §§ 100 et seq., 101, 102, 103, 112 and 132;

d. If the facts demonstrate that the case is exceptional within the meaning of 35 U.S.C. § 285, an award to AnkerDirect of its reasonable attorneys' fees, expenses, and costs associated with this action; and

e. Awarding AnkerDirect any other remedy or relief to which it may be entitled and which the Court deems just, proper, and equitable.

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DATED: September 13, 2023.

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Attorneys for Plaintiff Fantasia Trading, LLC d/b/a AnkerDirect

EXHIBIT A

US011660810B2

(12) **United States Patent**
Montgomery

(10) **Patent No.: US 11,660,810 B2**
(45) **Date of Patent: *May 30, 2023**

(54) **ADAPTABLE HIGH-PERFORMANCE EXTRUSION HEAD FOR FUSED FILAMENT FABRICATION SYSTEMS**

(71) Applicant: **Slice Engineering LLC**, Gainesville, FL (US)

(72) Inventor: **Christopher Mark Montgomery**, Austin, TX (US)

(73) Assignee: **Slice Engineering, LLC**, Gainesville, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 218 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/100,506**

(22) Filed: **Nov. 20, 2020**

(65) **Prior Publication Data**

US 2021/0069973 A1 Mar. 11, 2021

Related U.S. Application Data

(63) Continuation of application No. 15/981,615, filed on May 16, 2018.
(Continued)

(51) **Int. Cl.**
B29C 64/20 (2017.01)
B29C 64/209 (2017.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B29C 64/209*** (2017.08); ***B29C 64/106*** (2017.08); ***B29C 64/118*** (2017.08); ***B33Y 30/00*** (2014.12); *B29L 2031/767* (2013.01)

(58) **Field of Classification Search**
CPC B29C 64/209; B29C 64/106; B29C 47/80; B29C 67/00; B29L 2031/767;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

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(Continued)

OTHER PUBLICATIONS

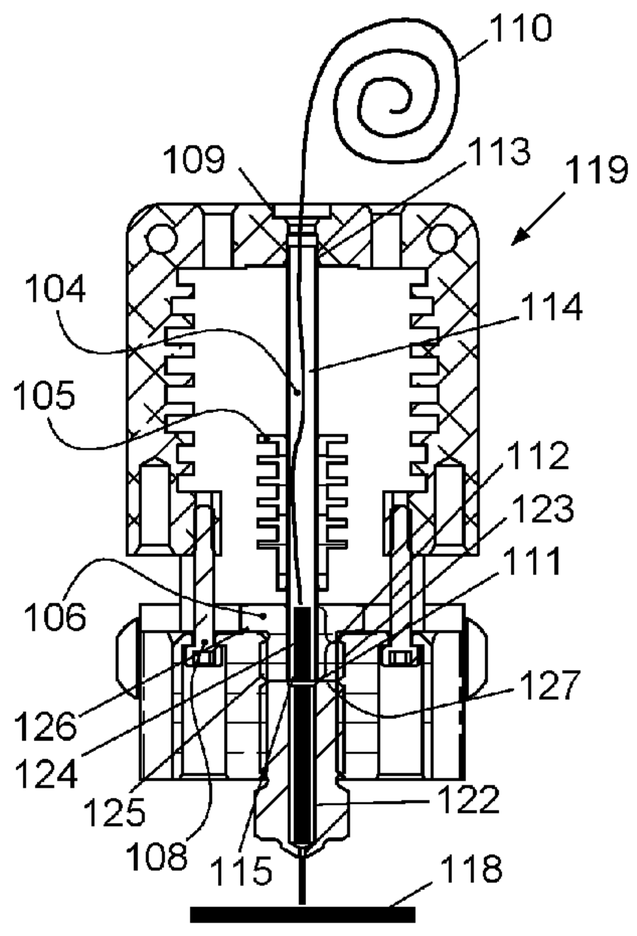
"How to specify Hypodermic tubing" by Micro Group (Year: 2020).*

Primary Examiner — Alison L Hindenlang
Assistant Examiner — Shibin Liang
(74) *Attorney, Agent, or Firm* — McAndrews, Held & Malloy, Ltd.

(57) **ABSTRACT**

An extrusion head for a three-dimensional printer is disclosed including a feed tube, a heater, a cooler, and a bridge. The feed tube can be made of metal and has an inlet for receiving a forwardly driven filament of solid deposition material, an outlet, a downstream portion adjacent to the outlet, an upstream portion upstream from the downstream portion, and an internal passage extending from the inlet to the outlet. The heater is thermally coupled with the downstream portion of the feed tube for heating a filament to provide softened fluid deposition material. The cooler is thermally coupled with the upstream portion and spaced generally axially from the heater to define a generally axially extending gap traversed by the feed tube. The bridge traverses the gap and provides a rigid mechanical connection between the heater and the cooler.

20 Claims, 4 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 62/507,728, filed on May 17, 2017.

(51) **Int. Cl.**

B33Y 30/00	(2015.01)
B29C 64/106	(2017.01)
B29C 64/118	(2017.01)
B29L 31/00	(2006.01)

(58) **Field of Classification Search**
CPC B33Y 10/00; B33Y 30/00; B33Y 40/00; B33Y 50/02; H05K 3/10; H05K 1/02
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2017/0064840	A1*	3/2017	Espalin	B33Y 80/00
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2019/0118467	A1*	4/2019	Neboian	B41J 2/51
2019/0184633	A1*	6/2019	Sydow	B29C 35/16

* cited by examiner

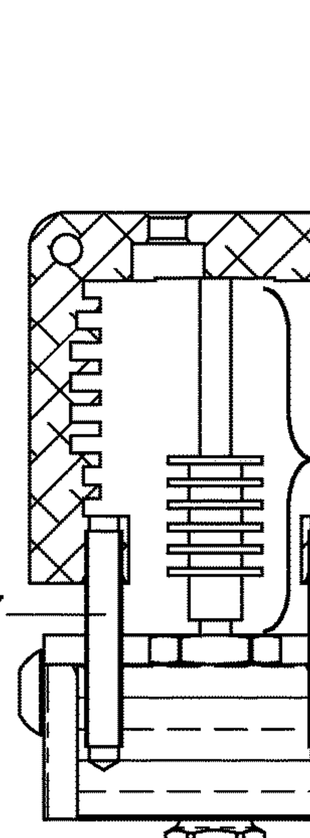

FIG. 7

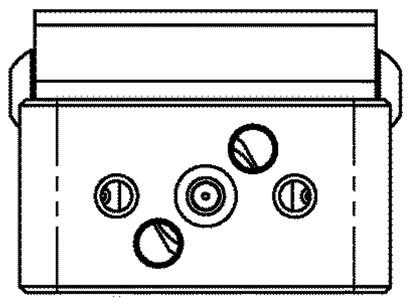

FIG. 5

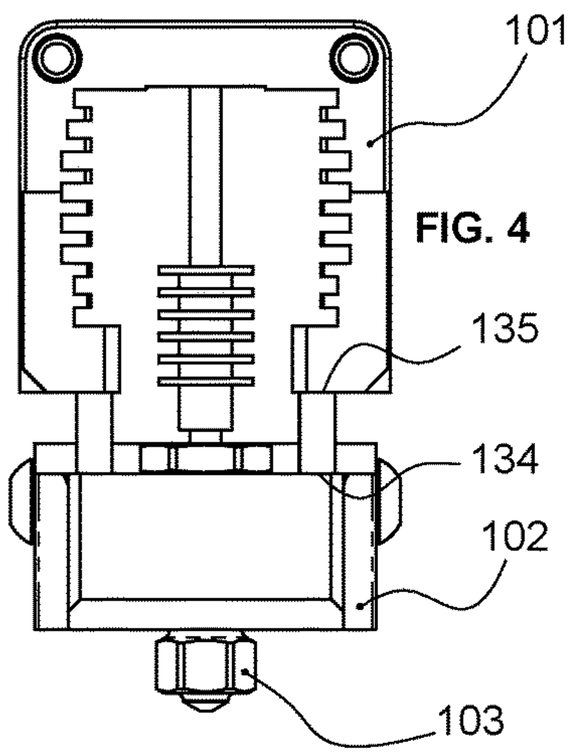

FIG. 4

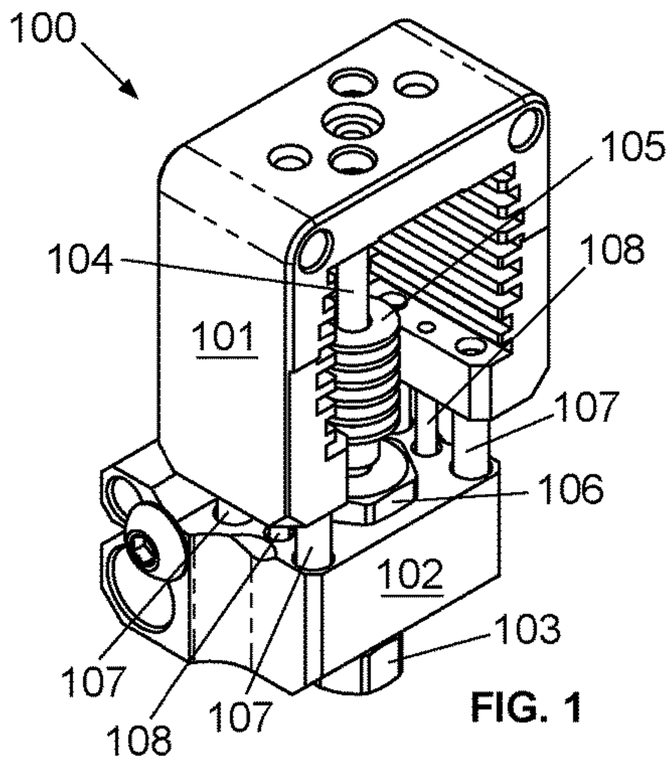

FIG. 1

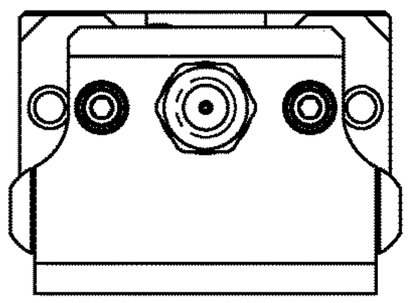

FIG. 6

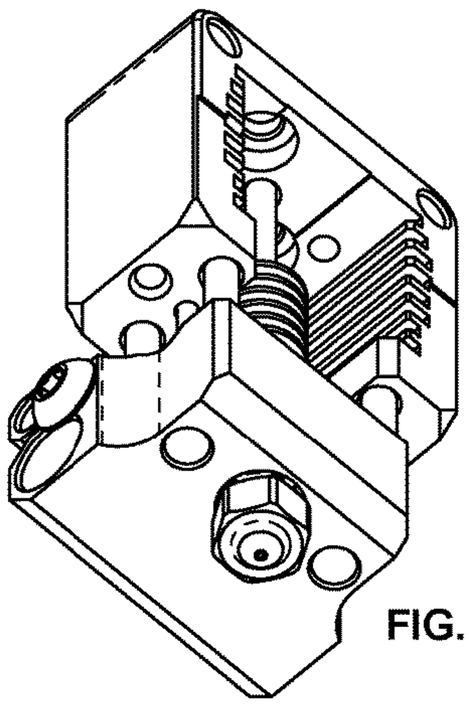

FIG. 2

FIG. 8

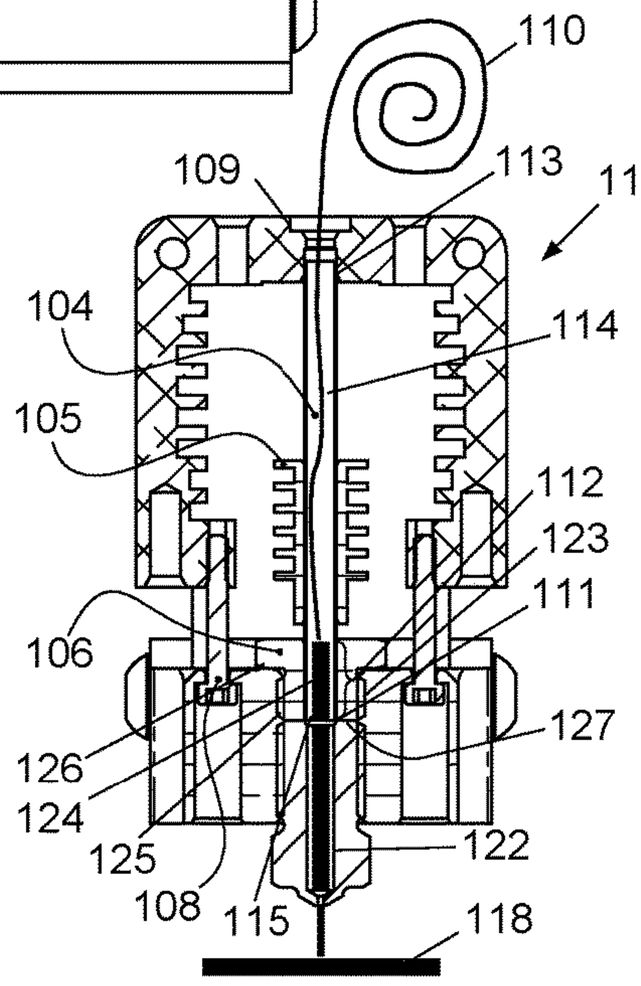

FIG. 9

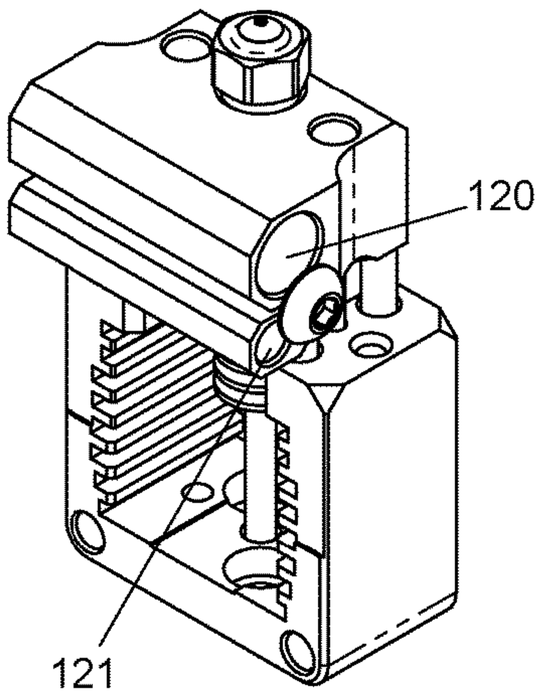

FIG. 3

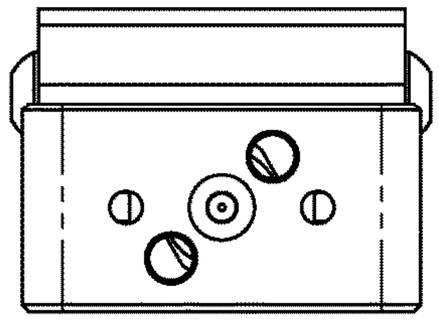

FIG. 14

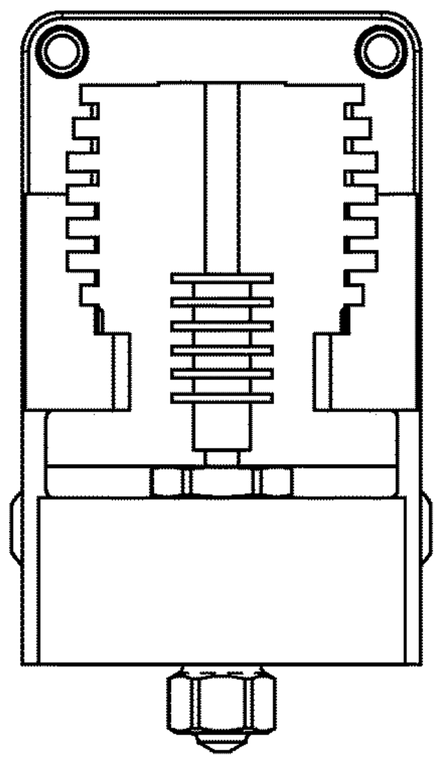

FIG. 13

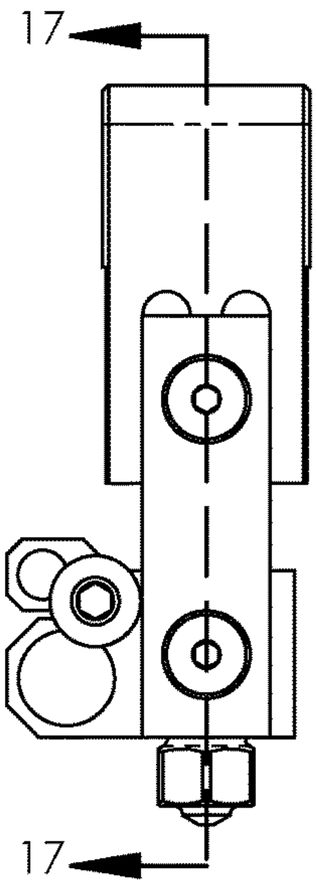

FIG. 16

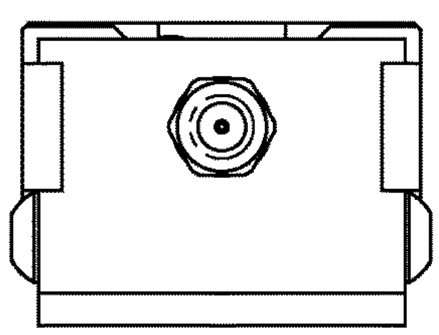

FIG. 15

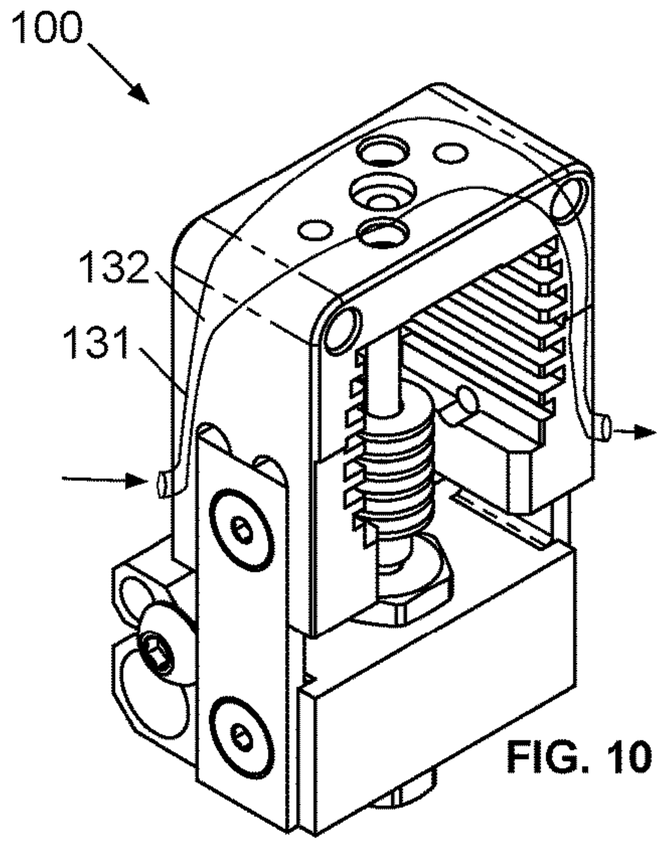

FIG. 10

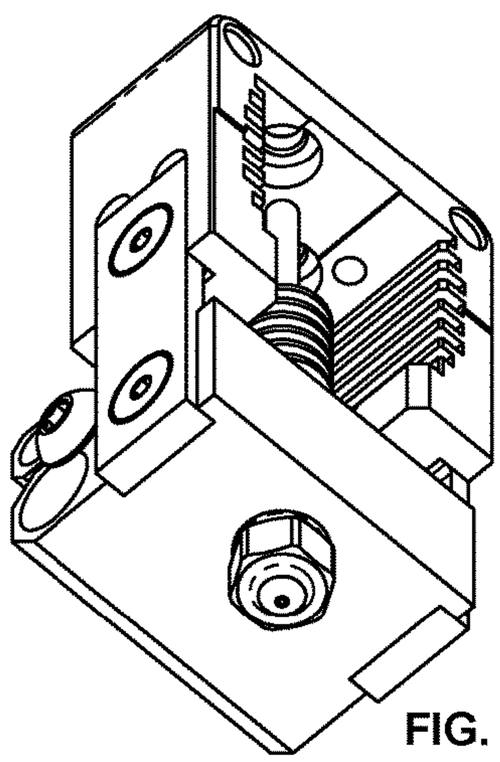

FIG. 11

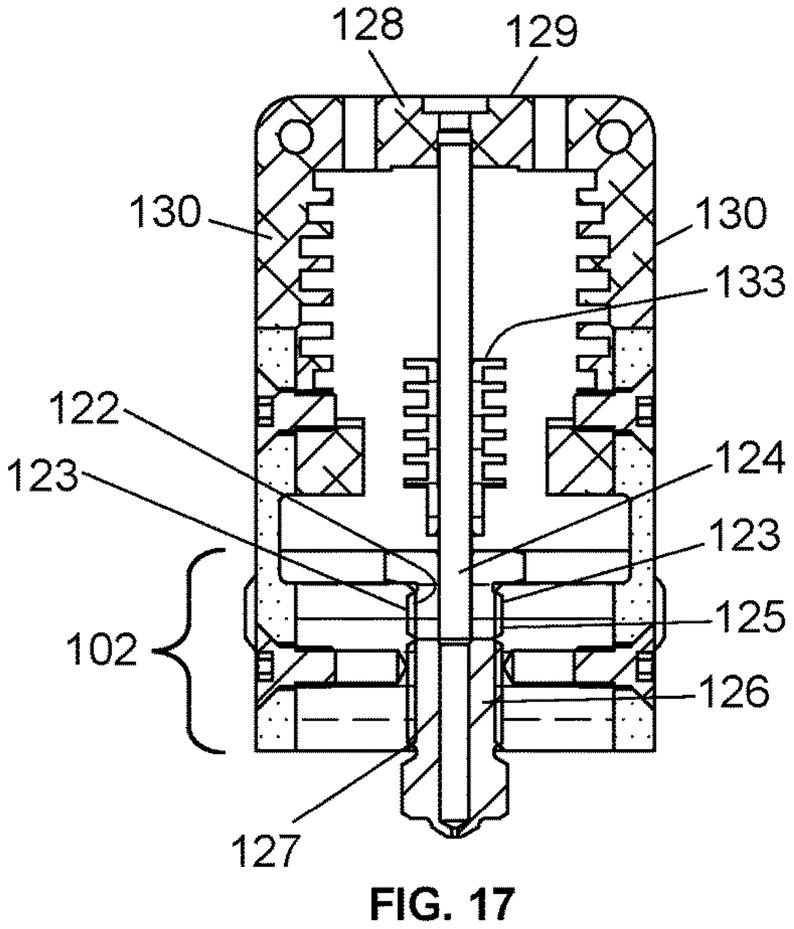

FIG. 17

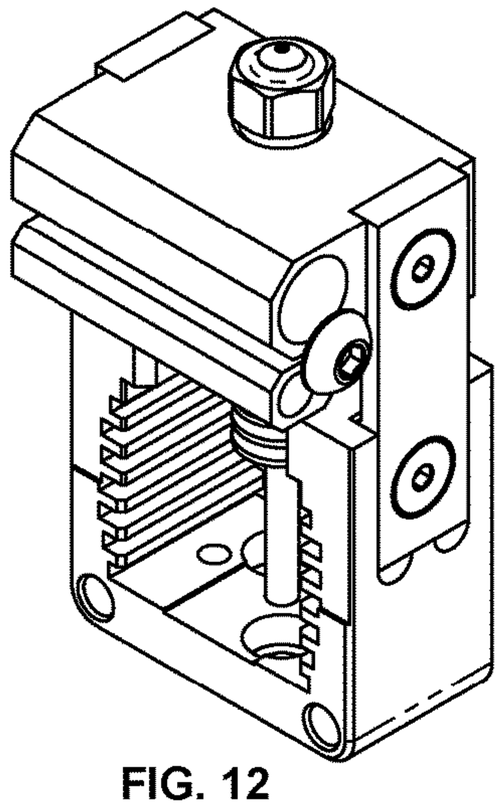

FIG. 12

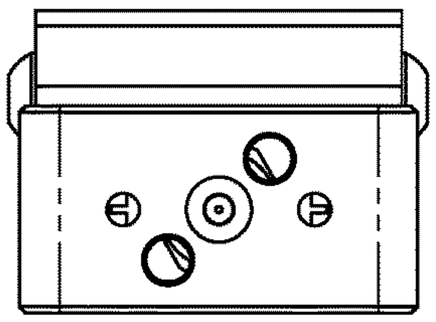

FIG. 22

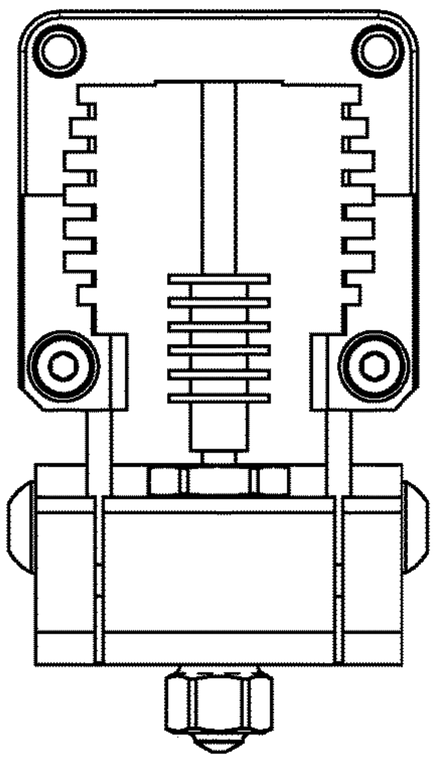

FIG. 21

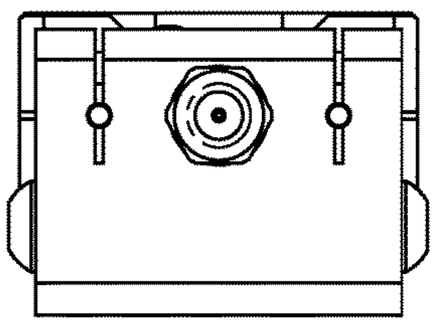

FIG. 23

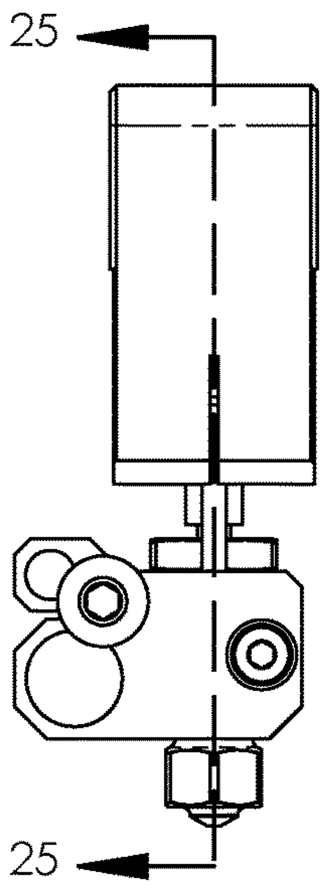

FIG. 24

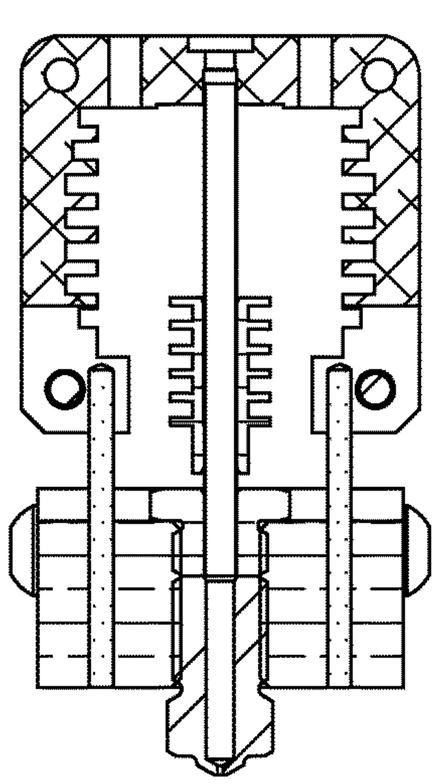

FIG. 25

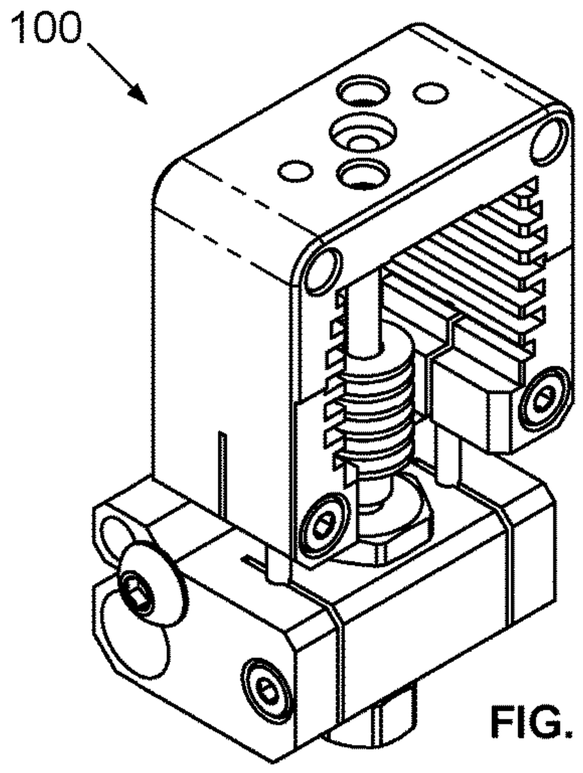

FIG. 18

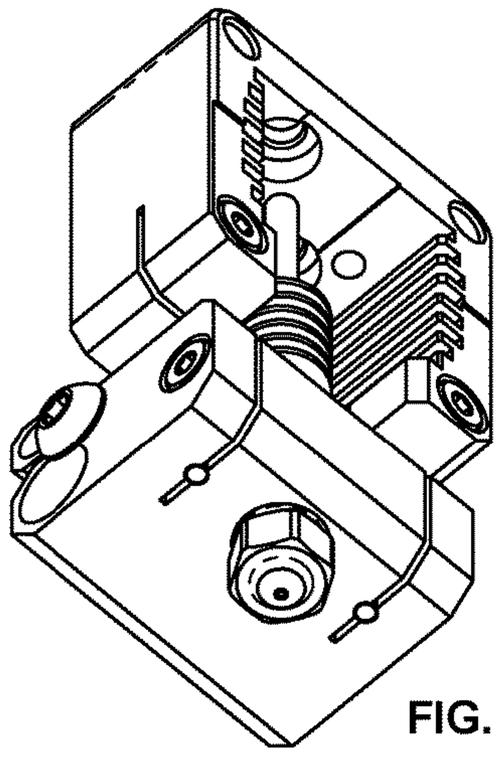

FIG. 19

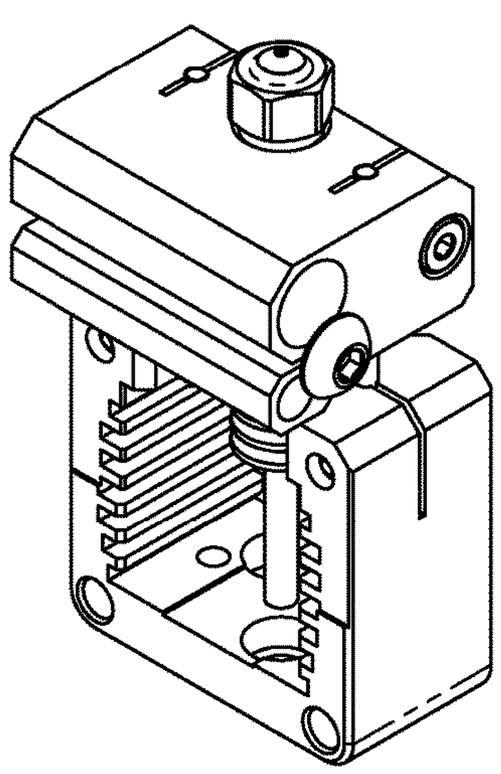

FIG. 20

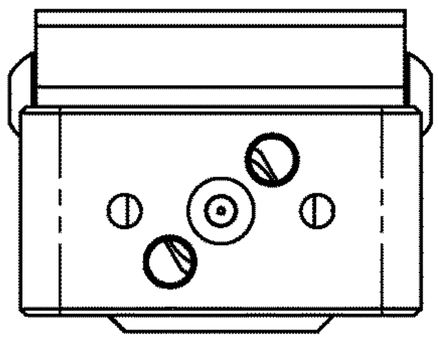

FIG. 30

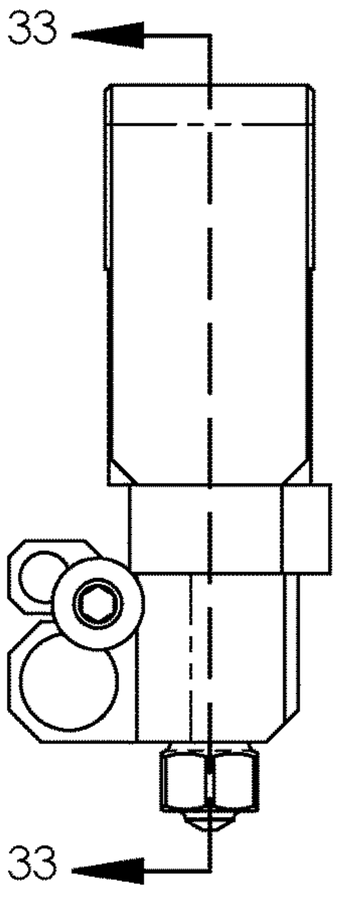

FIG. 32

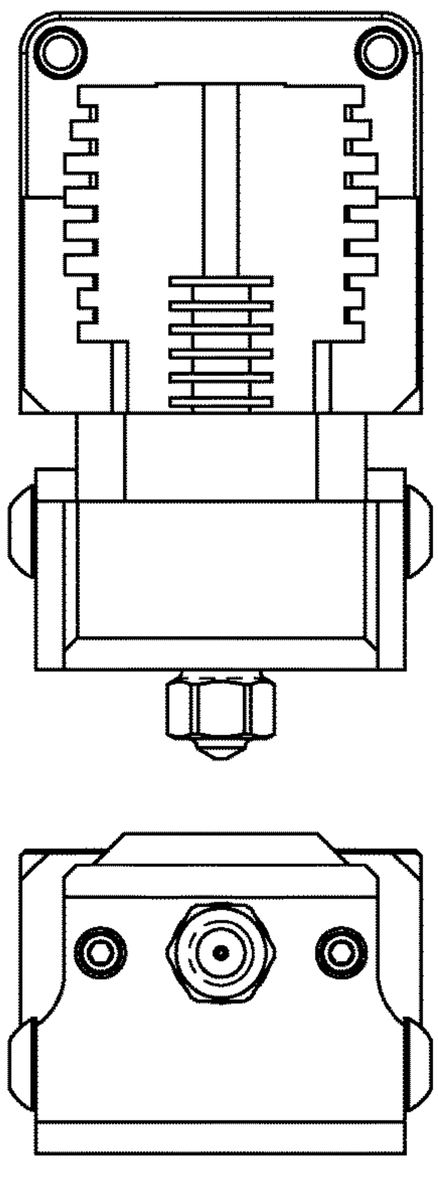

FIG. 29

FIG. 31

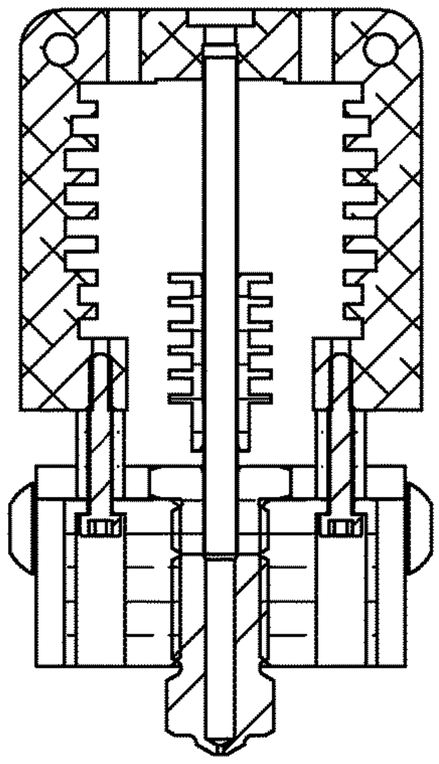

FIG. 33

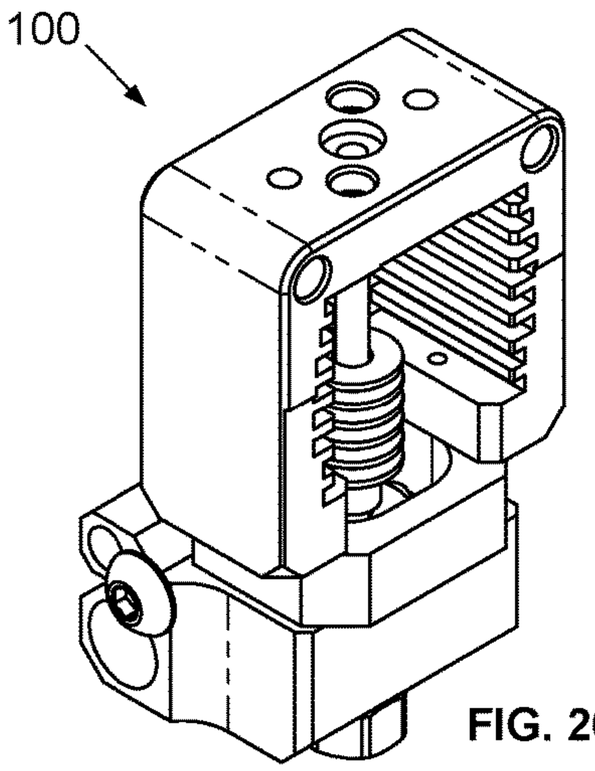

FIG. 26

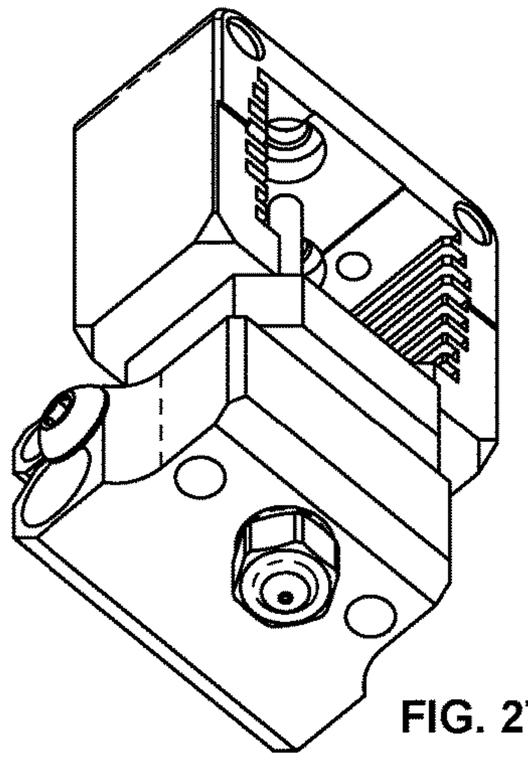

FIG. 27

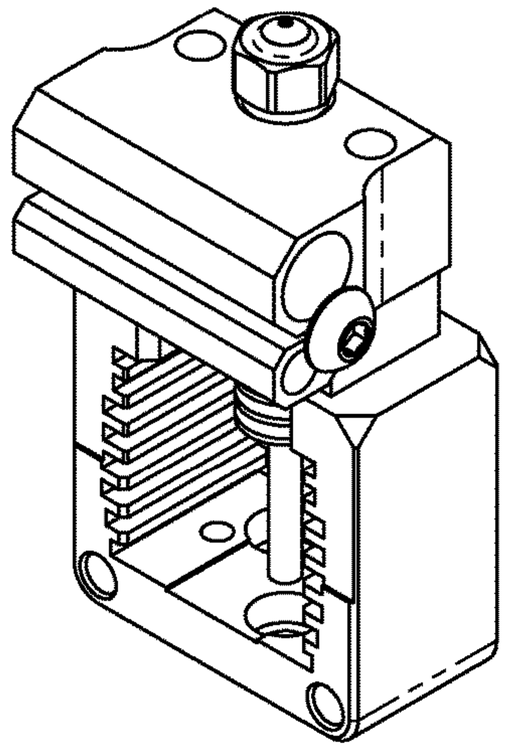

FIG. 28

ADAPTABLE HIGH-PERFORMANCE EXTRUSION HEAD FOR FUSED FILAMENT FABRICATION SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation application of co-pending U.S. patent application Ser. No. 15/981,615, filed May 16, 2018, which claims the priority of U.S. Provisional App No. 62/507,728, filed May 17, 2017. The entire content of both U.S. patent application Ser. No. 15/981,615 and U.S. Provisional App No. 62/507,728 is incorporated by reference herein.

BACKGROUND OF THE INVENTION

The invention relates to the thermal dispensing head for depositing layers of solidifying material in a desired pattern to form three-dimensional physical objects. The modeling material is selected and its temperature is controlled so that it solidifies upon extrusion from the dispensing head onto a base, with the build-up of multiple layers forming the desired article. This method of fabrication is often called Fused Filament Fabrication (FFF), and the thermal dispensing head for a FFF machine is often called the hot end.

Examples of apparatus and methods for FFF of three-dimensional objects by depositing layers of solidifying material are described in Crump U.S. Pat. No. 5,121,329; Batchelder et al. U.S. Pat. No. 5,303,141; Crump U.S. Pat. No. 5,340,433; Batchelder U.S. Pat. No. 5,402,351; Batchelder U.S. Pat. No. 5,426,722; Crump et al. U.S. Pat. No. 5,503,785; Abrams et al. U.S. Pat. No. 5,587,913; and Swanson et al. U.S. Pat. No. 6,004,124. The systems disclosed in the '329, '433, '785 patents and '124 patents, for example, describe an extrusion head which receives a solid state material used to form three dimensional articles, heats the material to above its solidification temperature, and dispenses the material as a fluid onto a base.

Various embodiments of the extrusion head are shown in the Crump '433 patent. Each embodiment includes a liquefier which consists of three zones: an entrance zone or cap, a heating zone or body and a nozzle. A first embodiment is shown in FIG. 3 of the '433 patent. FIG. 3 shows a liquefier within an extrusion head having a seal ring (i.e., a cap), a heating head (i.e., heating zone) and a nozzle. The seal ring receives a supply rod of solid material. An electric heater within the heating head heats the supply rod to a temperature exceeding its solidification temperature, reducing it to a liquid state. The liquid material then flows into the nozzle through a nozzle flow passage, and is dispensed through a nozzle dispensing outlet.

A second embodiment of the extrusion head is shown in FIG. 5 of the Crump '433 patent. In this embodiment, the supply material is in the form of a flexible strand in solid form. The flexible filament of material shown in FIG. 5 is fed through a guide sleeve to an extrusion head. The extrusion head contains a supply chamber in a top portion and a liquefier in a bottom portion. Drive rollers within the supply chamber introduce the flexible strand into the liquefier. The liquefier within the extrusion head includes a seal ring (i.e., a cap), a material supply and flow passage (i.e., heating zone) and a dispensing outlet orifice (i.e., a nozzle). The flexible strand is advanced into the liquefier through the seal ring, which provides a hydraulic seal around the internal surface of the flow passage. A heater in the form of a sleeve containing a heating coil is positioned around the flow passage and the orifice to heat the strand to a fluid state in the passage. The material is dispensed in a fluid state through the orifice.

A third embodiment of the extrusion head is shown in FIG. 13 of the Crump '433 patent. As with the embodiment shown in FIG. 5, the material is supplied in the form of a flexible strand in solid form. The strand is advanced into an extrusion head through a guide sleeve. A strand advance mechanism comprising a pair of motor-driven feed rollers or pulleys and advances the strand into the liquefier. The liquefier of FIG. 13 is comprised of a tubular guide member, a seal ring, a liquefier nozzle and a removable tip. The tubular guide member and seal ring together form the cap zone. The tubular guide member is made of highly conductive metal. It dissipates heat rapidly to maintain the flexible strand at a suitable temperature during its movement from the strand advance mechanism into the heating zone. To further dissipate heat from the guide member, a blower may be used to circulate air into the extrusion head, around the guide member. At its lower end, the guide member is supported on the seal ring. The seal ring is made out of heat-insulating plastic to serve as a thermal seal. The liquefier nozzle surrounded by a heating coil and an outer insulation sleeve provides a heating zone in which the strand material is melted. The liquefier nozzle (i.e., heating tube) is made of heat-conducting material. The removable tip is attached to the bottom end of the liquefier nozzle by a threaded connection.

A fourth embodiment of the extrusion head is shown in FIG. 6 of the Crump '433 patent. In this embodiment, multiple materials are dispensed through separate passages into a single discharge outlet. The embodiment of FIG. 6 allows utilization of different materials to form different layers of the same article.

The Crump '785 patent discloses an extrusion head carrying two liquefiers, each having its own nozzle. The liquefiers of the '785 patent each have a cap at a receiving end, secured by a mounting ring to a tubular dispenser (i.e., heating tube). A heating coil is wrapped around each tubular dispenser to heat and melt a filament of material. In each liquefier, the material is provided in a fluid state to a dispensing nozzle and discharged through a nozzle tip. Filament is conveyed to each liquefier from a supply spool by a pair of pinch rollers driven by stepper motors.

In the aforementioned liquefiers, the cap region serves as the transition zone for the modeling material where at the entrance to the cap the temperature is below the softening point of the material and the outlet of the cap is above the temperature required to pump the material in a semi-liquid state. This requires a change in temperature of up to 250° Celsius over the length of the cap. Ideal properties for the cap are a high thermal resistivity in the axial direction and low thermal resistivity in the radial direction. Designs such as those described in the Crump patents used high temperature thermoplastics or thermosets such as Dupont "Vespel" SP-1, for the cap to accomplish these goals. These caps have temperature limitations and require a sealing mechanism between the cap and the heating body, which is typically formed of aluminum. The caps and seal are prone to leakage.

A fifth embodiment of the extrusion head is shown in FIG. 9 of the '124 patent. In this embodiment, a liquefier formed of a single piece of thin-wall tubing is encased in a heating block. The tube acts as both the hot zone and the cold zone of the liquefier. The nozzle can be formed by swagging the metal tube to a nozzle, or it may be brazed or welded to the bottom of the tube. The heating block is made of heat conductive materials.

The thin-wall tube has an inlet end for receiving a filament of molding material and an outlet end for delivering the material in liquid form. A first section of the tube adjacent the inlet end functions as the entrance or cap zone. This first section of the tube is exterior to the heating block. The tube has a second section which passes through the heating block forming a heating zone. The nozzle connects to the outlet end of the tube. The cap zone of the tube must dissipate heat rapidly to maintain the flexible strand at a suitable temperature during its movement into the heating zone, so that the strand will not become limp and buckle. A stainless steel tube having a wall thickness in the range of 0.008-0.015 inches and an interior diameter of 0.07 inches is specified in the '124 patent.

Example products include: E3D V6, Prusa MKII, Lulzbot Hexagon, Dyze Dyzend-X and many others.

SUMMARY OF THE INVENTION

An aspect of the invention is an extrusion head for a three-dimensional printer. The extrusion head includes a feed tube, a heater, a cooler, and a bridge.

The feed tube can be made of metal and extends generally axially. The feed tube has an inlet for receiving a forwardly driven filament of solid deposition material, an outlet, a downstream portion adjacent to the outlet, an upstream portion upstream from the downstream portion, and an internal passage extending from the inlet to the outlet.

The heater is thermally coupled with the downstream portion of the feed tube for heating a filament positioned within the feed tube internal passage to provide softened fluid deposition material.

The cooler is thermally coupled with the upstream portion for reducing upstream heat transfer. The cooler is spaced generally axially from the heater to define a generally axially extending gap traversed by the feed tube.

The bridge is spaced radially from the metal feed tube, traverses the gap, and provides a rigid mechanical connection between the heater and the cooler.

Other aspects of the invention are described or will become apparent from the following description and the drawing figures.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIGS. **1**, **2**, and **3** are perspective views of an embodiment of the extrusion head.

FIG. **4** is a front elevation view of an embodiment of the extrusion head of FIGS. **1** through **3**.

FIG. **5** is a top plan view of an embodiment of the extrusion head of FIGS. **1** through **3**.

FIG. **6** is a bottom plan view of an embodiment of the extrusion head of FIGS. **1** through **3**.

FIG. **7** is a side elevation view of an embodiment of the extrusion head of FIGS. **1** through **3**.

FIG. **8** is a section view taken along section lines **8-8** of FIG. **7** of an embodiment of the extrusion head of FIGS. **1** through **3**.

FIG. **9** is a section view taken along section lines **9-9** of FIG. **7** of an embodiment of the extrusion head of FIGS. **1** through **3**.

FIGS. **10** through **12** are perspective views of an embodiment of the extrusion head.

FIG. **13** is a front elevation view of an embodiment of the extrusion head of FIGS. **10** through **12**.

FIG. **14** is a top plan view of an embodiment of the extrusion head of FIGS. **10** through **12**.

FIG. **15** is a bottom plan view of an embodiment of the extrusion head of FIGS. **10** through **12**.

FIG. **16** is a side elevation view of an embodiment of the extrusion head of FIGS. **10** through **12**.

FIG. **17** is a section view taken along section lines **17-17** of FIG. **16** of an embodiment of the extrusion head of FIGS. **10** through **12**.

FIGS. **18** through **20** are perspective views of an embodiment of the extrusion head.

FIG. **21** is a front elevation view of an embodiment of the extrusion head of FIGS. **18** through **20**.

FIG. **22** is a top plan view of an embodiment of the extrusion head of FIGS. **18** through **20**.

FIG. **23** is a bottom plan view of an embodiment of the extrusion head of FIGS. **18** through **20**.

FIG. **24** is a side elevation view of an embodiment of the extrusion head of FIGS. **18** through **20**.

FIG. **25** is a section view taken along section lines **25-25** of FIG. **24** of an embodiment of the extrusion head of FIGS. **18** through **20**.

FIGS. **26** through **28** are perspective views of an embodiment of the extrusion head.

FIG. **29** is a front elevation view of an embodiment of the extrusion head of FIGS. **26** through **28**.

FIG. **30** is a top plan view of an embodiment of the extrusion head of FIGS. **26** through **28**.

FIG. **31** is a bottom plan view of an embodiment of the extrusion head of FIGS. **26** through **28**.

FIG. **32** is a side elevation view of an embodiment of the extrusion head of FIGS. **26** through **28**.

FIG. **33** is a section view taken along section lines **33-33** of FIG. **32** of an embodiment of the extrusion head of FIGS. **26** through **28**.

A list of the reference characters used in the drawings follows.

100 Extrusion Head
101 Cooler
102 Heater
103 Nozzle
104 Feed Tube
105 Second Cooler
106 Bushing
107 Spacer
108 Tension Member
109 Inlet (of 104)
110 Filament
111 Outlet (of 104)
112 Downstream Portion (of 104)
113 Upstream Portion (of 104)
114 Internal Passage (of 104)
115 Softened Deposition Material
116 Gap
117 Bridge
118 Platform
119 Three-Dimensional Printer
120 Heating Element
121 Temperature Sensor
122 Threaded Bore (of 102)
123 External Thread (of 112)
124 Axial Bore (of 106)
125 Exterior Threaded Surface (of 106)
126 Inlet (of 122)
127 Outlet (of 122)
128 First Thermally Conductive Portion
129 Second Thermally Conductive Portion
130 Thermally Conductive Flange Portion
131 Internal Heat Transfer Passage
132 Cooling Fluid

-continued

133 Sleeve (Heat Sink)
134 First Portion (of 107)
135 Second Portion (of 107)

DETAILED DESCRIPTION OF THE DISCLOSURE

FIGS. **1** to **33** show exemplary extrusion heads **100** for a three-dimensional printer or similar device **119** also including a supply of filament material **110**, a part support base **118**, and a mechanism, which can be conventional, for moving the extrusion head **100**, the building table **118**, or both relative to the other. The extrusion head **100** includes, for example, a cooler **101**, a heater **102**, a nozzle **103**, a feed tube **104**, a second cooler **105**, a bushing **106**, a spacer **107**, and a tension member **108**.

The feed tube **104** in this embodiment is made of metal, and extends generally axially. The feed tube **104** has an inlet **104** for receiving a forwardly driven filament **110** of solid deposition material, an outlet **111**, a downstream portion **112** adjacent to the outlet **111**, an upstream portion **113** upstream from the downstream portion **112**, and an internal passage **114** extending from the inlet **104** to the outlet **111**.

The heater **102** is thermally coupled with the downstream portion **112** for heating a filament **110** positioned within the feed tube **104** internal passage **114** to provide softened deposition material **115**.

The cooler **101** is thermally coupled with the upstream portion **113** for reducing upstream heat transfer. The cooler **101** is spaced generally axially upstream from the heater **102** to define a generally axially extending gap **116** traversed by the metal feed tube **104**.

A bridge **117** (for example, at least one spacer **107** or at least one tension member **108**) is spaced radially from the metal feed tube **104**, traversing the gap **116**, and providing a rigid mechanical connection between the heater **102** and the cooler **101**.

Optionally in any embodiment, the metal feed tube **104** comprises stainless steel or zirconia, and suitably can be made from hypodermic tubing.

Optionally in any embodiment, the hypodermic tubing is sized from 10×× to 14×× gauge.

Optionally in any embodiment, the metal feed tube **104** has a wall thickness from 0.001 to 0.005 in. (0.025 mm to 0.13 mm), a wall thickness less than 0.005 in. (less than 0.13 mm), or from 0.001 to 0.004 in. (0.025 mm to 0.1 mm), or from 0.002 to 0.004 in. (0.05 mm to 0.1 mm).

Optionally in any embodiment, the metal feed tube **104** has a wall cross-sectional area from 0.002 in^2 to 0.005 in^2(1 mm^2 to 3 mm^2), or from 0.0017 $in^2$to 0.004 in^2(1.1 to 2.6 mm^2).

Optionally in any embodiment, the metal feed tube **104** has an inside diameter from 0.07 in. to 0.13 in. (1.8 mm to 3.3 mm), or from 0.07 in. to 0.11 in. (1.8 mm to 2.8 mm).

Optionally in any embodiment, the metal feed tube **104** has a length from 0.5 in. to 3 in. (12 mm. to 76 mm.). Optionally in any embodiment, the portion of the feed tube **104** traversing the gap **116** extends axially from 0.03 in. to 3 inches (0.8 mm. to 76 mm.).

Optionally in any embodiment, the metal feed tube **104** internal passage **114** is coated internally with a material reducing adhesion of the deposition material, for example, electroless nickel, an electroless nickel-boron composite, tungsten disulfide, molybdenum disulfide, boron nitride, diamond-like carbon, zirconium nitride, titanium nitride, or a combination of two or more of these.

Optionally in any embodiment, the heater **102** comprises a heater block comprising thermally conductive material, at least one heating element **120**, and at least one temperature sensor **121** attached to and in thermal contact with the heater block **102**. Optionally in any embodiment, the heater block has an axial length from 0.2 inches to 1.5 inch (5 mm. to 38 mm.). The heater block can have a threaded bore **122**.

Optionally in any embodiment, the feed tube **104** downstream portion **112** has an external thread **123**, and the heater block **102** threaded bore **122** and the feed tube **104** external thread **123** are engaged to thermally couple the heater block **102** with the downstream portion **112** of the feed tube **104**. Alternatively, the extrusion head **100** of claim 20 includes a bushing **106** having an axial bore **124** defined by a wall secured to the feed tube **104** downstream portion **112**, the bushing **106** further comprising an exterior threaded surface **125** engaged with the heater block **102** threaded bore **122**. Optionally, the heater block **102** threaded bore **122** extends from an inlet **126** communicating with the feed tube downstream portion to an outlet **127**.

Optionally in any embodiment, the extrusion head **100** includes a nozzle **103** secured to the heater block **102** threaded bore **122** and communicating with the outlet **127** of the heater block **102** threaded bore **122**.

Optionally in any embodiment, the cooler **101** comprises a thermoelectric cooler or a heat sink comprising heat-conductive material. Optionally in any embodiment, the heat sink has at least a first thermally conductive portion **128** thermally coupled with the upstream portion **113** of the feed tube **104** and a second thermally conductive portion **129** generally radially spaced from the upstream portion **113** of the feed tube **104**. Optionally in any embodiment, the heat sink has a thermally conductive flange portion **130** extending generally axially from the second thermally conductive portion **129** and parallel to and radially spaced from the feed tube **104**. Optionally in any embodiment, the heat sink has at least first and second thermally conductive flange portions **130**, each extending generally axially from the second thermally conductive portion **129**, parallel to and radially spaced from the feed tube **104**, and the first thermally conductive flange portion **130** circumferentially spaced from the second thermally conductive flange portion **130**.

Optionally in any embodiment, the heat sink comprises an internal heat transfer passage **131** configured to receive a cooling fluid **132**.

Optionally in any embodiment, the heat sink comprises a bore in thermal contact with the feed tube **104** along at least a portion of the gap **116**.

Optionally in any embodiment, the bridge **117** comprises a generally axially extending spacer **107**, spaced radially from the feed tube **104**. Optionally in any embodiment, the spacer **107** has at least a first portion **134** bearing against the heater **102** and a second portion **135** bearing against the cooler **101**. Optionally in any embodiment, the bridge **117** comprises first and second generally axially extending spacers **107**, each spaced radially from the feed tube **104**, each having at least a first portion **134** bearing against the heater **102** and a second portion **135** bearing against the cooler **101**. Optionally in any embodiment, the extrusion head **100** has a third generally axially extending spacer **107**, spaced radially from the feed tube **104**, and having at least a first portion **134** bearing against the heater **102** and a second portion **135** bearing against the cooler **101**. Optionally in any embodiment, the extrusion head **100** has a fourth generally axially extending spacer **107**, spaced radially from the feed tube

104, and having at least a first portion **134** bearing against the heater **102** and a second portion **135** bearing against the cooler **101**.

Optionally in any embodiment, the spacer **107** at least partially reduces mechanical loading on the feed tube **104**.

Optionally in any embodiment, the spacer **107** comprises stainless steel, zirconia, or a combination of stainless steel and zirconia, for example hypodermic tubing. Examplary suitable hypodermic tubing is sized between 7 XX and 14 XX gauge, inclusive, for example, 7 XX, 8 XXX, 8 XX, 9 XXX, 9 XX, 10 XX, 11 XX, 12XX, 13 XX, 14 XX, or a combination of two or more of these. Optionally in any embodiment, the spacer **107** comprises thermal insulation material, for example, calcium silicate, ceramic, glass, an engineering thermoplastic, zirconia, mica, Portland cement or a combination of any two or more of these.

Optionally in any embodiment, the extrusion head **100** further comprises at least a first tension member **108** spaced radially from the feed tube **104** and connected to and exerting tension between the heater **102** and the cooler **101**. Optionally second, third, or fourth tension members **108** can be provided.

Optionally in any embodiment, the total cross-sectional area of the tension members **108** and spacers **107** is less than 0.01 square inches (6.4 mm.^{2}). Optionally, the sum of the contact areas of the tension members and spacers with the heater is between 0.005 in.^{2} and 0.02 in.^{2}(0.25 mm.^{2} and 3.2 mm. 2) and with the cooler is between 0.005 in.^{2} and 0.02 in.^{2} (0.25 mm.^{2} and 3.2 mm.2).

The inventor contemplates two design tradeoffs inherent in existing all-metal extrusion head designs:

First, the heat break's thermal isolation performance is proportional to the length of and inversely proportional to the wall thickness of the thin-walled section. Poor thermal isolation results in filament softening prematurely and reduction in print quality alluded to in the '124 patent. The requirement for the heat break to carry a mechanical load is therefore at odds with its performance. The extrusion head designer must select the heat break's wall thickness to withstand reasonable incidental loads caused by machine crashes, failed prints, or human mishandling. In this manner the structural requirement put on the heat break hinders performance of the extrusion head, which in turn hinders the overall performance of the FFF machine.

Second, the hot end designer may lengthen the hot zone and select a nozzle of large bore diameter to maximize potential speed of printing, or he may shorten the hot zone and select a small-bore nozzle to maximize printing resolution. Additionally, some extrusion head designs allow users to affect the length of the hot zone by swapping or adding components. Example products: E3D V6-to-Volcano conversion kits, DisTech Prometheus V2. In all such products the overall length of the extrusion head changes when the user affects the hot zone's length, which is an undesirable side effect. A change in overall length of the extrusion head requires the user to calibrate the machine's recorded offset from nozzle to print bed. Failure to perform said calibration results in a failed print or the nozzle crashing into the print bed.

Existing all-metal extrusion heads borrow many design features from the '124 patent, and they all utilize a component known as a heat break to thermally isolate the heater block from cold components. The heat break typically:

a. Consists of a cannulated threaded rod with two threaded sections separated by a thin-walled section several millimeters in length,

b. Features a thin-walled section with inner diameter and wall thickness typically in the range specified by the '124 patent for the thin-walled tube,

c. Is made of stainless steel,

d. Connects to a finned heatsink or a liquid cooling system, and

e. Is the only component connecting the heater block to cold components. I.e. the heat break not only functions as a thermal isolator but also as the mechanical structure carrying the heater block.

In the present improved extrusion head for FFF systems, the liquefier component can be formed of a single piece of thin-wall tubing pressed, brazed, or welded to a bushing of varying length. The thin-walled tube acts as both the hot zone and the cold zone of the liquefier. The inlet of the thin-walled tube slip-fits into a hole in the cold section. The thin-walled tube can be swagged, brazed or welded to a bushing in thermal contact with the heating block. The inlet of a removable nozzle can seal with the outlet of the bushing. The heating block and bushing are made of heat conductive materials, such as aluminum alloys or copper alloys, preferably a chromium copper alloy due to its combination of thermal conductivity and high strength at the highest temperature ranges commonly encountered in FFF applications.

Unlike other all-metal hot ends, the thin-walled tube does not need to be a structural member. Nor does the tube need to cantilever from an externally supported heater block as described in the '124 patent. Since it optionally can be partially or completely relieved of mechanical loading, the wall thickness of the tube can be greatly reduced to improve its thermal isolation performance. The tube's wall thickness is in the range of 0.001 to 0.005 inches. The tube thickness used in prototypes has been 0.003 inches, in the form of commercially available 14×× gauge hypodermic tubing made of stainless steel. Such a drastic reduction in the heat break's wall thickness optionally removes the need for a finned heatsink component or liquid cooling system and reduces the fan size needed to keep the cold zone cool. The overall length and girth of the extrusion head may be reduced, conserving valuable space in a typically crowded area of the FFF system, and the overall mass may be reduced.

Bushings of varying length may be user-installed to effectively shorten or lengthen the hot zone, to affect the speed/resolution trade off described above. In arrangement employed in the present invention, the bushing extends upward in the direction of the cold zone rather than down below the heater block. In this manner, bushings of various lengths may be used without affecting the overall length of the hot end, preserving the recorded offset to the print bed, and preventing the need for the user to recalibrate the machine after making adjustments.

The heater block optionally connects to cold zone components via two to four standoffs and zero to four screws. Optionally, three screws with three standoffs or the preferable two screws with four standoffs can be used. The standoffs are preferably made of thin-walled tubes or small-diameter rods, and the screws are of small cross-sectional area. The standoffs may be constructed off blocks of rigid insulation materials such as calcium silicate based materials. Preferably the standoffs and screws incorporate materials with a high ratio of strength to thermal conductivity, such as stainless steel or zirconia. The structural components connecting the cold and hot zones are loaded only in compression (standoffs) and tension (screws) to resist the rapidly-changing axial push-pull forces applied by the filament feed system. Components between hot and cold zones are not

loaded in bending, providing maximum axial rigidity for a given axial cross-sectional area of the standoff components. The total cross-sectional area of the standoff structure optionally is minimized to minimize the heat flowing from the heater block to cold zone components. For all prototypes of the present invention, this cross-section was less than 0.01 square inches in area and the structure consisted of stainless steel screws and tubular standoffs.

Optionally, the cold section is composed of a hollow heatsink component of a basically square outer shape, with inward-facing slits for heat dissipation by convection. This component's nominal wall thickness excluding the slits is roughly one fifth the overall width of the square hollow component, and this component is made of aluminum alloy. Above this component an adapter is attached to guide the filament from the feed system into the thin-walled feed tube. The ideal geometry for this adapter is specific to the FFF system. Use of an adapter allows the extrusion head to be installed on a wide variety of makes and models of FFF systems. Since the adapter is located at the coldest region of the extrusion head, it need not be made of metal. Users are free to design and make their own adapters via FFF or any manufacturing method convenient to them.

Optionally, commercially available stainless steel hypodermic tubing is used for the standoffs. Four of these standoffs lightly press into mating counter bores in the cold section and in the heater block. A pair of M1.4×0.3 screws pulls the heater block toward the cold section, establishing the compressive forces in the standoffs. The tube optionally is pressed into the bushing, which optionally threads into the heater block.

Optionally, a heatsink is pressed onto the thin-walled tube. Performance is not noticeably affected by omission of this heatsink.

Optionally, the heater block is made of chromium copper (aka C182) and is coated with Cerakote Glacier Series ceramic coating. The coating reduces heat lost via convection and radiation. Electroless nickel plating would also work well due to its low thermal emissivity.

I claim:

1. An extrusion head for a three-dimensional printer, the extrusion head comprising:

a generally axially extending metal feed tube having an inlet for receiving a forwardly driven filament of solid deposition material, an outlet, a downstream portion adjacent to the outlet, an upstream portion upstream from the downstream portion, and an internal passage extending from the inlet to the outlet;

a heater thermally coupled with the downstream portion for heating a filament positioned within the feed tube internal passage to provide softened deposition material;

a cooler thermally coupled with the upstream portion for reducing upstream heat transfer, the cooler spaced generally axially upstream from the heater; and

a generally axially extending gap, bound by a bridge traversing the gap between the cooler and the heater; wherein,

the gap is traversed by the metal feed tube;

the bridge is spaced radially and apart from the metal feed tube, the bridge provides a rigid mechanical connection between the heater and the cooler, and the bridge at least partially reduces mechanical loading on the feed tube, wherein the bridge comprises:

a first structural component, spaced radially and apart from the feed tube, and having a first portion bearing against the heater and a second portion bearing against the cooler, wherein the first structural component at least partially relieves mechanical loading on the feed tube; and

a second structural component, spaced radially and apart from the feed tube, and having a first portion bearing against the heater and a second portion bearing against the cooler, wherein the second structural component at least partially relieves mechanical loading on the feed tube.

2. The extrusion head of claim **1**, wherein at least one of the first structural component or the second structural component is a spacer or tension member.

3. The extrusion head of claim **1**, wherein the bridge further comprises a third structural component, spaced radially and apart from the feed tube, and having a first portion bearing against the heater and a second portion bearing against the cooler, wherein the third structural component at least partially relieves mechanical loading on the feed tube.

4. The extrusion head of claim **1**, wherein the metal feed tube comprises stainless steel.

5. The extrusion head of claim **4**, wherein the metal feed tube comprises hypodermic tubing.

6. The extrusion head of claim **1**, wherein the metal feed tube has a wall thickness less than 0.005 in. (less than 0.13 mm).

7. The extrusion head of claim **1**, wherein the metal feed tube has an inside diameter from 0.07 in. to 0.13 in. (1.8 mm to 3.3 mm).

8. The extrusion head of claim **1**, wherein the metal feed tube has a length from 0.5 in. to 3 in. (12 mm. to 76 mm.).

9. The extrusion head of claim **1**, wherein the portion of the feed tube traversing the gap extends axially from 0.03 in. to 3 inches (0.8 mm. to 76 mm.).

10. The extrusion head of claim **1**, wherein the metal feed tube internal passage is coated internally with a material reducing adhesion of the deposition material.

11. The extrusion head of claim **10**, wherein the material reducing adhesion of the deposition material is electroless nickel, an electroless nickel-boron composite, tungsten disulfide, molybdenum disulfide, boron nitride, diamond-like carbon, zirconium nitride, titanium nitride, or a combination of two or more of these.

12. The extrusion head of claim **1**, further comprising a bushing having an axial bore defined by a wall secured to the feed tube downstream portion, the bushing further comprising an exterior threaded surface engaged with the heater block threaded bore.

13. The extrusion head of claim **12**, wherein a line drawn from the first structural component to the second structural component passes through the bushing.

14. The extrusion head of claim **1**, wherein the first structural component and the second structural component of the bridge are each loaded in either compression or tension to resist the axial push-pull forces applied by the filament feed system.

15. The extrusion head of claim **1**, wherein the cooler comprises a heat sink comprising heat-conductive material.

16. The extrusion head of claim **1**, wherein the cooler comprises a heat sink comprising heat-conductive material and comprising an internal heat transfer passage configured to receive a cooling fluid.

17. The extrusion head of claim **1**, wherein at least one structural component comprises hypodermic tubing.

18. The extrusion head of claim **17**, wherein the hypodermic tubing is sized between 7 XX and 14 XX gauge, inclusive.

19. The extrusion head of claim **1**, wherein at least one-structural component comprises thermal insulation material.

20. The extrusion head of claim **19**, wherein the thermal insulation material is calcium silicate, ceramic, glass, an engineering thermoplastic, zirconia, mica, Portland cement or a combination of any two or more of these.

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EXHIBIT B

RE:[CASE 13633300231] Notice: Amazon Patent Evaluation Express Program - Action Required

发件人： **'patent-evaluation@amazon.com' via Anker direct<ankerdirec...** 2023年8月24日 (周四) 23:24
收件人： ankerdirect@anker.com<ankerdirect@anker.com>

Hello,

We received a report from a patent owner who believes the items listed at the end of this email infringe their U.S. Patent No. 11,660,810.

If you wish to continue selling the items listed at the end of the email, you have two choices.

First, you can choose to resolve your claim with the patent owner directly within the next three weeks. If we receive a retraction from the patent owner within the next three weeks, we will allow you to continue selling the items listed at the end of this email. The patent owner's contact information is as follows:

Slice Engineering LLC
info@sliceengineering.com
747 SW 2nd Ave Suite 296 Gainsville FL 32601

If the patent owner agrees to retract their complaint, they must send the retraction directly to us at patent-evaluation@amazon.com. Forwarded retractions will not be accepted. Another option is to resolve the claim with the patent owner in a federal district court case. If you are already engaged in a patent lawsuit with the patent owner, or if you file a lawsuit against the patent owner for declaratory judgment of non-infringement of the asserted patent, please provide us with a copy of the relevant complaint within the next three weeks, and you may continue selling the items listed at the end of the email while the lawsuit proceeds.

Second, you can choose to participate in neutral evaluation of the patent owner’s claim. Amazon’s neutral evaluation procedure is described in the attached document titled “Amazon Patent Evaluation Express Procedure.” Please read this document carefully and note that payment of a deposit is required. If you choose to participate in the neutral evaluation, you must agree to the attached Amazon Patent Evaluation Express Agreement, complete Exhibit 2 of the Agreement, “Seller-Supplied Information,” and return the completed Agreement to patent-evaluation@amazon.com within three weeks.

Please note that participation in the evaluation process does not guarantee that you will be able to continue to sell the items listed at the end of this email following the evaluation. If the evaluator decides that the items likely infringe, we intend to remove them from Amazon.com. If, however, the evaluator decides the items likely do not infringe, we will not remove your listings from Amazon.com, and your deposit may be refunded in part or in full.

If you do not either resolve your claim with the patent owner directly, or agree to participate in the neutral evaluation process, we will remove the listings at the end of this email from Amazon.com.

To learn more about this policy, search for “Intellectual Property Violations” in Seller Central Help.

ASIN: B0CDH1JMTF
B0CDBQPPWC
B0C2HMQB15
Infringement type: Patent
Patent Number: 11,660,810
Case ID: 13633300231

You can learn more about your account health in the Performance section of Seller Central (https://sellercentral.amazon.com/gp/seller-rating/pages/performance-summary.html).

Neutral Patent Evaluation Team
Amazon.com

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2 个附件 (452.5 KB)

Amazon Patent Evaluation Express Procedure
PDF - 166.5 KB

Slice Engineering LLC Executed Agreement
PDF - 286.0 KB