



- (51) International Patent Classification:
F23D 1/00 (2006.01) *F23L 7/00* (2006.01)
- (21) International Application Number:
PCT/CN2024/140562
- (22) International Filing Date:
19 December 2024 (19.12.2024)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
202311839725.5 28 December 2023 (28.12.2023) CN
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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, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,

(54) Title: BURNER

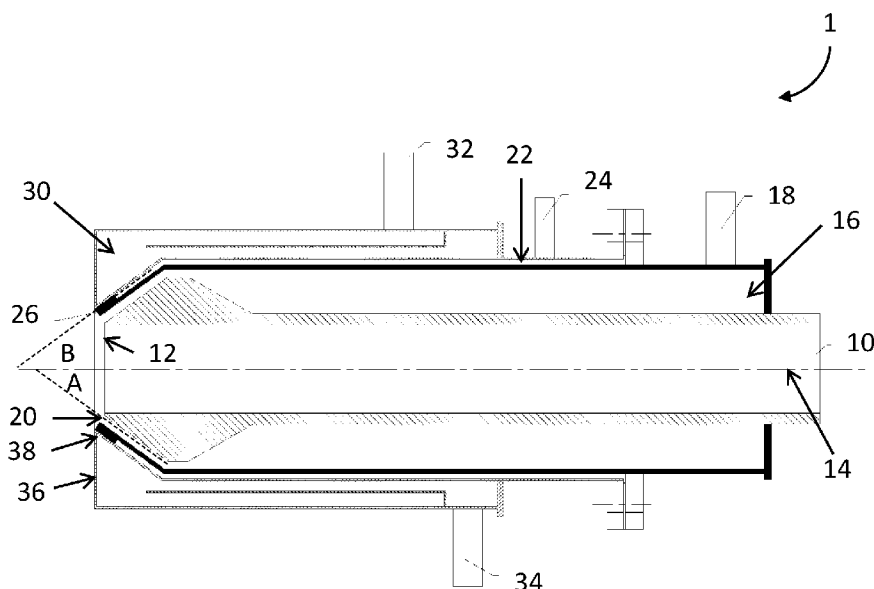


Fig. 1

(57) Abstract: A burner comprising a first channel surrounding a centerline and terminating in a first tip; a second channel surrounding the first channel and terminating in a second tip, the second channel comprising a convergent conical section forming a first angle with respect to the centerline; a third channel surrounding the second channel and terminating in a third tip, the third channel comprising a convergent conical section forming a second angle with respect to the centerline; wherein the third tip comprises one or more slots.

NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,
RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, 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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

BURNER

TECHNICAL FIELD

[0001] The present invention relates generally to a burner, specifically to a burner of a gasification system, and more specifically to advanced apparatus for injecting feeds into a gasifier.

BACKGROUND

[0002] At least some known gasifiers convert a mixture of fuel, air or oxygen, liquid water and/or steam, and/or fluxant and/or auxiliary additives into an output of partially oxidized gas, commonly referred to as "synthesis gas" or "syngas." The partial oxidation or gasification of solid carbon-containing fuels such as coal to produce gases having value as residential and industrial fuels, as starting materials for synthesis of chemicals and fuels, and as an energy source for generation of electricity has long been recognized and practiced on varying scales throughout the world.

[0003] The fuel, air or oxygen, liquid water and/or steam, and/or fluxant or auxiliary additives are injected into the gasifier from separate sources through a feed injector that couples the sources of the feed components to a feed nozzle. The feed components traverse the feed injector separately and are combined in a reaction zone downstream of the nozzles. For the reaction to complete in the short time the feed is in residence in the reaction zone, intimate mixing of the feed components needs to occur. At least some known gasification feed injectors are designed to inject the feed components into the reaction zone at high velocity to encourage atomization, however such methods reduce the reaction time available and tend to inhibit effective conversion.

SUMMARY

[0004] The object of the present invention is to provide a burner, which can provide more reaction time available and facilitate effective conversion of the feeds.

[0005] The following summarizes several technical solutions of the burner according to the present invention.

[0006] Technical Solution 1. A burner comprising:

a first channel surrounding a centerline and terminating in a first tip;

a second channel surrounding the first channel and terminating in a second tip, the second channel comprising a convergent conical section forming a first angle with respect to the centerline;

a third channel surrounding the second channel and terminating in a third tip, the third channel comprising a convergent conical section forming a second angle with respect to the centerline;

wherein the third tip comprises one or more slots.

[0007] Technical Solution 2. The burner of Technical Solution 1, wherein the first channel comprises a section of constant cross-sectional area terminating at the first tip.

[0008] Technical Solution 3. The burner of Technical Solution 1, wherein the one or more slots have a swirl angle less than or equal to 15 degrees.

[0009] Technical Solution 4. The burner of Technical Solution 1, wherein the first angle ranges from 10 to 50 degrees.

[0010] Technical Solution 5. The burner of Technical Solution 1, wherein the value of the second angle minus the first angle ranges from 0 to 10 degrees.

[0011] As compared to the prior art, the burner according to the present invention has one or more slots in the third tip, which can provide more reaction time available and facilitate effective conversion of the feeds.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present invention will hereinafter be described in conjunction with the appended figures wherein like numerals denote like elements:

[0013] Fig. 1 is a cross-sectional side schematic view of a burner according to one or more aspects of the present disclosure.

[0014] Fig. 2A is a schematic view of the front of a burner tip according to one or more aspects of the present disclosure.

[0015] Fig. 2B is a schematic view of a modification of Fig. 2A in which a burner tip has one or more conical slots.

[0016] Fig. 2C is a schematic view of a modification of Fig. 2A in which a burner tip has one or more conical slots with a swirl angle.

DETAILED DESCRIPTION

[0017] The ensuing detailed description provides preferred exemplary embodiments only, and is not intended to limit the scope, applicability, or configuration of the invention. Rather, the ensuing detailed description of the preferred exemplary embodiments will provide those skilled in the art with an enabling description for implementing the preferred exemplary embodiments of the invention. Various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the invention.

[0018] The articles "a" or "an" as used herein mean one or more when applied to any feature in embodiments of the present invention described in the specification. The use of "a" and "an" does not limit the meaning to a single feature unless such a limit is specifically stated. The article "the" preceding singular or plural nouns or noun phrases denotes a particular specified feature or particular specified features and may have a singular or plural connotation depending upon the context in which it is used.

[0019] The term "and/or" placed between a first entity and a second entity includes any of the meanings of (1) only the first entity, (2) only the second entity, or (3) the first entity and the second entity. The term "and/or" placed between the last two entities of a list of 3 or more entities means at least one of the entities in the list including any specific combination of entities in this list. For example, "A, B and/or C" has the same meaning as "A and/or B and/or C" and comprises the following combinations of A, B and C: (1) only A, (2) only B, (3) only C, (4) A and B but not C, (5) A and C but not B, (6) B and C but not A, and (7) A and B and C.

[0020] The adjective "any" means one, some, or all, indiscriminately of quantity.

[0021] The phrase "at least a portion" means "a portion or all." The "at least a portion of a stream" has the same composition, with the same concentration of each of the species, as the stream from which it is derived.

[0022] As used herein, "first," "second," "third," etc. are used to distinguish among a plurality of steps and/or features, and is not indicative of the total number, or relative position in time and/or space, unless expressly stated as such.

[0023] "Downstream" and "upstream" refer to the intended flow direction of the process fluid transferred. If the intended flow direction of the process fluid is from the first device to

the second device, the second device is downstream of the first device. In case of a recycle stream, downstream and upstream refer to the first pass of the process fluid.

[0024] Fig. 1 is a cross-sectional side schematic view of a burner 1 according to one or more aspects of the present disclosure. First channel 10 may be configured to deliver a carbonaceous fuel to a gasifier (not shown) via first tip 12. In some embodiments the carbonaceous fuel may be pulverized coal suspended in a carrier gas. First channel 10 may be symmetric around centerline 14 and may be straight and non-tapering, that is to say that the cross-sectional area of the first channel 10 is constant. A straight and non-tapering first channel may reduce turbulence and erosion caused by impingement of coal particles on the walls of the first channel 10. Second channel 16 may concentrically surround first channel 10 and may be configured to deliver an oxidant such as oxygen, oxygen-steam mixtures, or an oxygen-enriched gas via oxidant inlet 18. Second channel 16 may be configured to deliver oxidant via second tip 20 at a first angle A with respect to the centerline 14 in order to improve mixing and atomization of the carbonaceous fuel which may reduce flame length and ensure complete reaction. Reducing flame length may improve operation especially in side-firing gasifiers by preventing the flame from impinging on the opposite wall. Longer flames also may cause overheating in the burner. First angle A may range from 10 to 50 degrees, or from 20 to 45 degrees. Third channel 22 may concentrically surround second channel 16 and may be configured to deliver an inert gas such as carbon dioxide, nitrogen, steam, or mixtures thereof, via inert inlet 24. The thickness of third channel 22 may be greater than 1 mm. Inert gas may be delivered at a velocity greater than or equal to 5 m/s under all operating conditions. Third channel 22 may be configured to deliver inert gas via third tip 26 at a second angle B with respect to the centerline 14. Second angle B may range from 10 degrees to 60 degrees, or from 30 to 60 degrees. The value of second angle B minus first angle A may range from 0 to 10 degrees.

[0025] Cooling jacket 30 may surround the third channel 22 to protect the burner internals (defined as the first channel 10, second channel 16, and third channel 22) from the high temperatures generated in the gasifier. Coolant such as water may be delivered into the cooling jacket via coolant inlet 32 and exit via coolant outlet 34. Coolant may be supplied at a higher pressure than the pressure of the gasifier, for example at a pressure 10 bar higher than that of the gasifier. A thin wall front 36 facing the gasifier may have a thickness ranging from 1.5 to 5 mm. The thin wall front 36 may be constructed of a high-temperature, high-strength alloy with corrosion resistance such as high nickel alloys

including Alloy 718 or Alloy 188. Inner rim 38 of thin wall front 36 may be rounded to reduce thermal stress.

[0026] The burner internals and cooling jacket may be constructed as a removable burner head, connected to a burner body comprising pipes and flanges (not shown) via a burner connector (not shown). The burner connector may comprise an internal connector and an outer connector that can be easily dismantled. The burner connector may comprise a single connector.

[0027] Fig. 2A is a schematic view of the front of a burner tip according to one or more aspects of the present disclosure. Second tip 20 is visible behind third tip 26. First channel 10 is visible in the center of the burner. Fig. 2B is a schematic view of a modification of Fig. 2A in which third tip 26 has one or more conical slots 40. The one or more conical slots 40 may be rectangular sections removed from the third tip 26 as shown in Fig. 2A, or may be any other shape that provides a portion of flow in the third channel a shorter path to exit the burner. One or more conical slots 40 may allow a reduction in the flow rate of inert gas needed to maintain sufficient gas velocity. One or more conical slots 40 may also reduce the risk of blockage of the third channel. One or more conical slots 40 may provide a gap size of at least 2 mm. Fig. 2C is a schematic view of a modification of Fig. 2A in which third tip 26 has one or more conical slots 40 with a swirl angle C with respect to a line radially drawn from the burner center. Swirl angle C may be less than 15 degrees, or may range from 0 degrees to 15 degrees. Swirl angle C may improve the shielding effect of the inert gas and may also improve mixing in the flame. Conical slots may not be required in the second tip 20 because there is typically a greater flow of oxidant than inert gas, and placing conical slots in the second tip 20 with a swirl angle may increase mixing of oxygen and fuel to the point that the flame is generated too close to the burner front and produces an excessive heat flux to the burner. Conversely, when there is a low flow rate of inert gas through the third channel 22, increased mixing by the conical slots 40 in the third tip 26 may be beneficial. In applications where the inert gas flow rate through the third channel 22 is high, such as when using high heating value fuels like anthracite and petcoke, conical slots may not be required.

[0028] Accordingly, the present disclosure may provide systems for delivering a carbonaceous fuel to a gasifier. The systems may include any of the various features disclosed herein, including one or more of the following aspects.

[0029] Aspect 1: A burner comprising a first channel surrounding a centerline and terminating in a first tip; a second channel surrounding the first channel and terminating in a second tip, the second channel comprising a convergent conical section forming a first angle with respect to the centerline; a third channel surrounding the second channel and terminating in a third tip, the third channel comprising a convergent conical section forming a second angle with respect to the centerline; wherein the third tip comprises one or more slots.

[0030] Aspect 2: A burner according to Aspect 1, wherein the first channel comprises a section of constant cross-sectional area terminating at the first tip.

[0031] Aspect 3: A burner according to Aspect 1 or Aspect 2, wherein the one or more slots have a swirl angle less than or equal to 15 degrees.

[0032] Aspect 4: A burner according to any of Aspects 1 to 3, wherein the first angle ranges from 10 to 50 degrees.

[0033] Aspect 5: A burner according to any of Aspects 1 to 4, wherein the value of the second angle minus the first angle ranges from 0 to 10 degrees.

[0034] While the principles of the invention have been described above in connection with preferred embodiments, it is to be clearly understood that this description is made only by way of example and not as a limitation of the scope of the invention.

CLAIMS

1. A burner comprising:
 - a first channel surrounding a centerline and terminating in a first tip;
 - a second channel surrounding the first channel and terminating in a second tip, the second channel comprising a convergent conical section forming a first angle with respect to the centerline;
 - a third channel surrounding the second channel and terminating in a third tip, the third channel comprising a convergent conical section forming a second angle with respect to the centerline;characterized in that the third tip comprises one or more slots.
2. The burner of claim 1, wherein the first channel comprises a section of constant cross-sectional area terminating at the first tip.
3. The burner of claim 1, wherein the one or more slots have a swirl angle less than or equal to 15 degrees.
4. The burner of claim 1, wherein the first angle ranges from 10 to 50 degrees.
5. The burner of claim 1, wherein the value of the second angle minus the first angle ranges from 0 to 10 degrees.

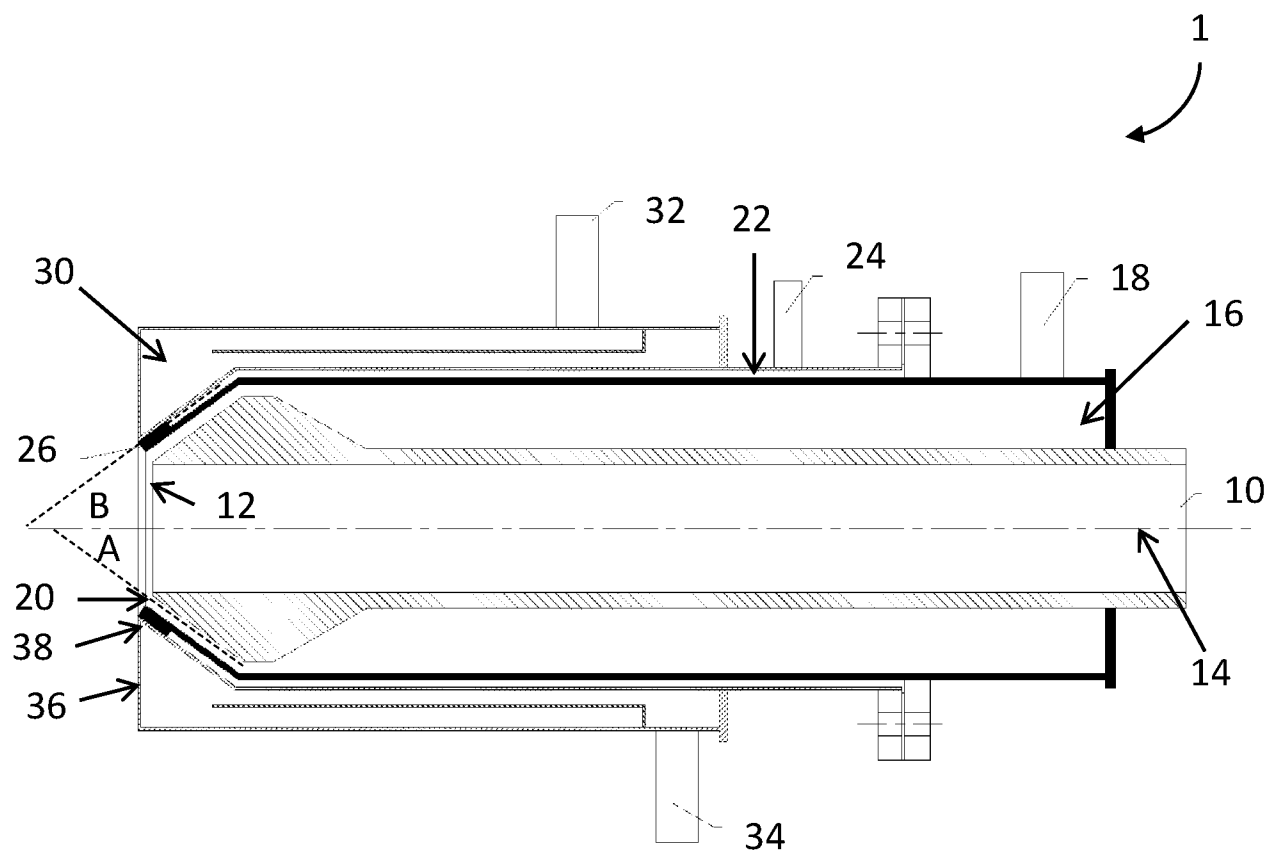


Fig. 1

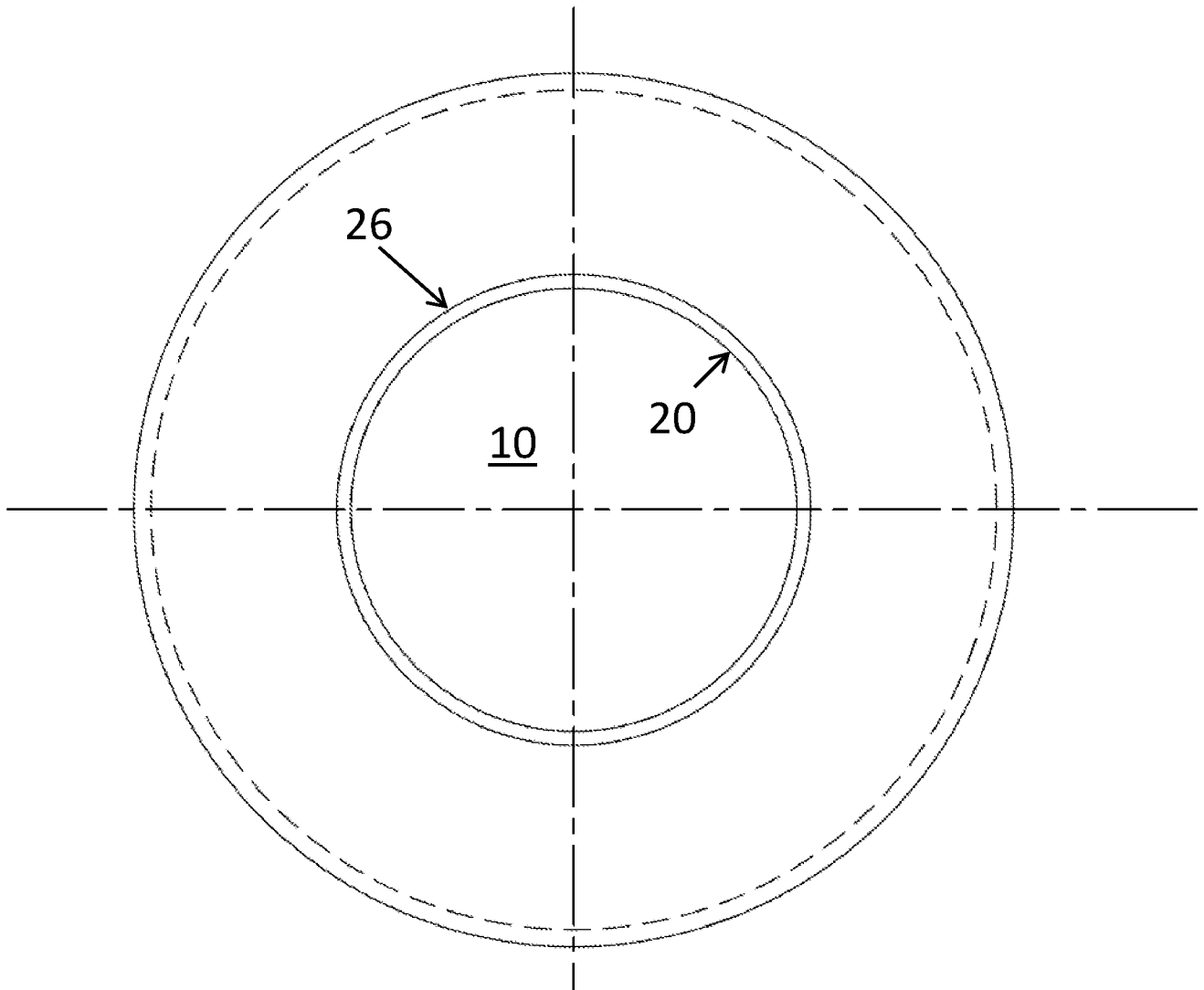


Fig. 2A

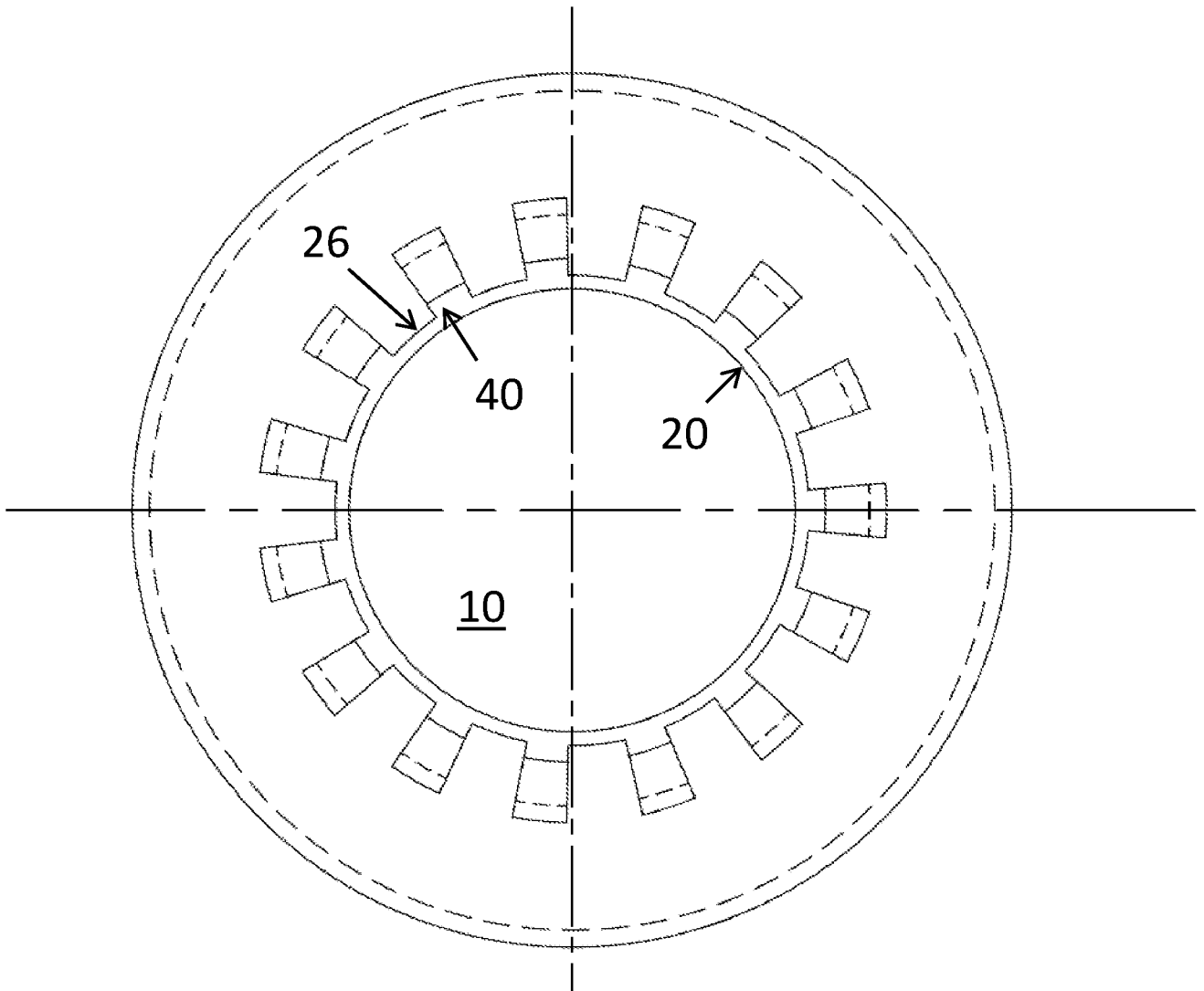


Fig. 2B

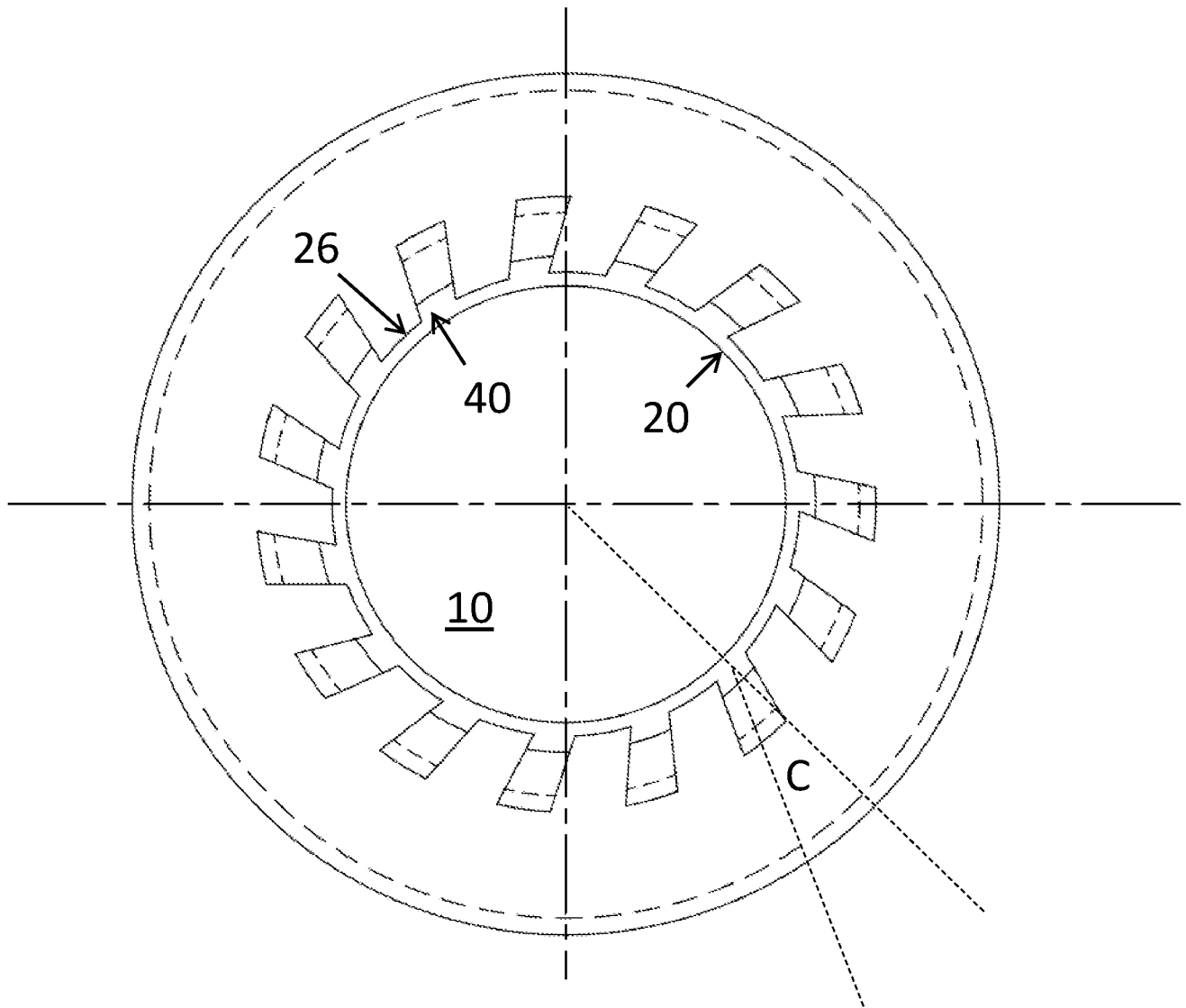


Fig. 2C

INTERNATIONAL SEARCH REPORT

International application No

PCT/CN2024/140562

A. CLASSIFICATION OF SUBJECT MATTER INV. F23D1/00 F23L7/00 ADD.		
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) F23D F23L Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 9 079 199 B2 (MISHRA NIRAJ KUMAR [IN]; GEN ELECTRIC [US]) 14 July 2015 (2015-07-14) column 6, line 38 - column 9, line 3 figures 2,3 -----	1 - 5
X	US 7 506 822 B2 (GEN ELECTRIC [US]) 24 March 2009 (2009-03-24) column 2, line 39 - column 3, line 64 figures 1,2 -----	1, 4, 5
X	CN 102 311 811 B (YANKUANG LUNAN CHEMICAL FERTILISER PLANT) 29 May 2013 (2013-05-29) translation figures 1-4 -----	1, 4, 5
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* 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 18 March 2025		Date of mailing of the international search report 31/03/2025
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Gavriliu, Costin

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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