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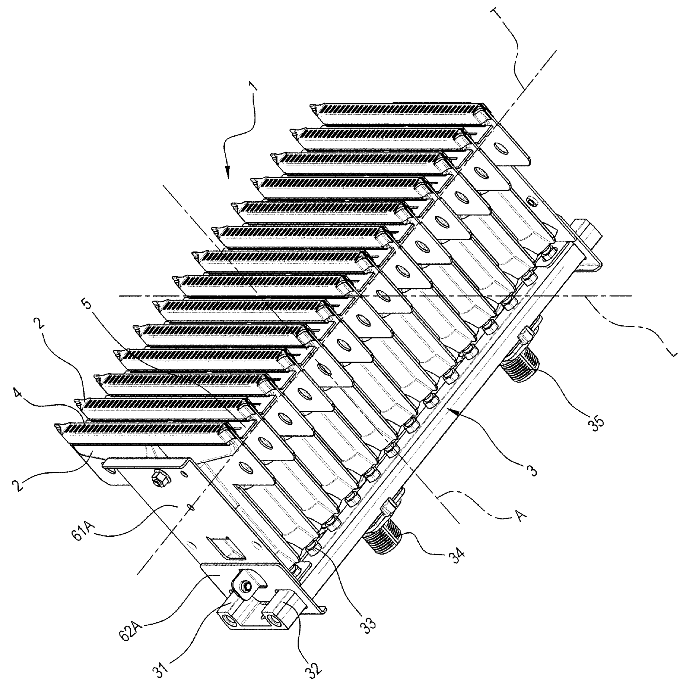
(71) Applicant: **Polidoro S.p.A.**
36015 Schio (VI) (IT)

(72) Inventors:
- **PESERICO, Domenico**
  36078 Valdagno (VI) (IT)
- **CAVASSO, Valter**
  36036 Torrebelvicino (VI) (IT)
- **PAGLIARO, Pietro**
  36100 Vicenza (VI) (IT)

(74) Representative: **Conti, Marco**
Bugnion S.p.A.
Via di Corticella, 87
40128 Bologna (IT)

(54) **GAS BURNER**

(57) An air-cooled gas burner (1) comprises: a plurality of ramp-like elements (2), each of which includes a first and a second intake duct (21, 22), having a respective inlet (21A, 22A) and a respective outlet (21B, 22B), wherein the plurality of ramp-like elements (2) are disposed in succession along a transverse direction (T); a manifold (3), configured to feed the gas to the inlets of the first and second intake ducts (21, 22), wherein the first and second intake ducts (21, 22) are configured to suck the gas and primary air into their respective inlets (21A, 22A) by the Venturi effect; for each ramp-like elements (2), a respective diffuser (4), defining a plurality of holes (40) from which a flame is generated by combustion of the gas coming from the first and the second intake duct (21, 22).



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Description

[0001] This invention relates to a gas burner and to a method for burning gas.

[0002] In particular, the burner of the invention is applicable in boilers and water heaters. Known in this field are burners that include a plurality of elements (or ramps or plates) disposed parallel to each other and, inside them, defining ducts in which the gas is fed through a manifold located at a first end of the elements. The gas is sucked into the ducts together with air, called primary air, and reaches a second end (or head) of the elements, where there is a diffuser from which the gas produces a flame that propagates into a combustion chamber. Known in the prior art are burners where each element (or ramp or plate) defines two ducts, configured to take in the primary air and the gas in parallel; burners of this kind are particularly advantageous in terms of uniform distribution of gas to the diffuser, hence of heat fluxes generated in the combustion chamber. Examples of burners with two intake ducts are described, for example, in the following patent documents: FR2745891B1, WO2016/193904, CN204438118U. Other examples of burners are provided in the following patent documents: DE4207814A1, EP1201990A1 and DE3338126A1.

[0003] Prior art burners give off large quantities of nitrous emissions (emissions of nitrogen oxides, NO_x) and other toxic substances and also have problems of flame stability. In particular, if combustion occurs under stoichiometric or hypostoichiometric conditions, the heads of the elements get overheated, leading to high emissions of NO_x and also of carbon monoxide; this problem is particularly evident when the burner is used with thermal powers that are near to the minimum of the operating range. To overcome this problem, some prior art burners, such as the one described in document WO2016/193904, in the name of the present Applicant, use a water cooling system that allows the heads to be kept at a low temperature, thus ensuring that NO_x emissions remain at a low level over the entire operating range. Such a cooling system, however, is very expensive and weighs heavily on the final cost of the burner.

[0004] This disclosure has for an aim to provide a burner and a method for burning gas that overcome the above mentioned disadvantages of the prior art. This aim is fully achieved by the burner and the method of this disclosure, as characterized in the appended claims.

[0005] According to one aspect of it, this disclosure relates to a gas burner. By gas, or gas fuel, is meant a natural gas consisting at least predominantly of methane. Preferably, the burner is air cooled. Preferably, the burner is without a water cooling system.

[0006] The burner comprises a plurality of ramp-like (or plate-like) elements. The ramp-like elements are disposed parallel to each other. More specifically, each ramp-like element lies in a respective extension plane parallel to a longitudinal direction and to an intake direction. Thus, the positioning planes of the ramp-like elements are parallel to each other.

[0007] Each ramp-like element comprises a first intake duct and a second intake duct. For each ramp-like element, the first intake duct and the second intake duct have a respective inlet. For each ramp-like element, the first intake duct and the second intake duct may have a respective outlet (preferably, each of these outlets extending longitudinally for half of the whole length of the ramp); alternatively, the first intake duct and the second intake duct may have a common outlet (which preferably extends longitudinally for the whole length of the ramp). Preferably, the first and the second intake duct are geometrically symmetrical to each other; more specifically, they are symmetrical about an axis oriented along the intake direction and interposed between the first and second intake ducts. Preferably, the first and second intake ducts are configured in such a way that the air-fuel ratio (also called lambda) is constant, that is to say, it is the same in both the first and the second intake duct.

[0008] In one or more embodiments, each ramp-like element also comprises a third intake duct. In an embodiment, each ramp-like element might also comprise a fourth and/or a fifth intake duct. The first and the second intake duct (and, if provided, the third and/or the fourth and/or the fifth intake duct) are oriented in the extension plane of the respective ramp-like element. The first and the second intake duct (and, if provided, the third and/or the fourth and/or the fifth intake duct) are spaced from each other along a direction; this direction may be (in a first example) the longitudinal direction (in this case, preferably, the inlets of the intake ducts are oriented vertically), or, alternatively (in a second example), may be spaced vertically (in this case, preferably, the inlets of the intake ducts are oriented longitudinally). In both of these examples, the outlet or outlets of the intake ducts may be oriented vertically.

[0009] The first and the second intake duct (and, if provided, the third and/or the fourth and/or the fifth intake duct) extend, between inlet and outlet, along a direction having at least one component that is parallel to the intake direction. It should be noted that the first and the second intake duct (and, if provided, the third and/or the fourth and/or the fifth intake duct) might not be parallel to each other; in effect, each one of them extends in a direction having one component that is parallel to the intake direction but it may also have other components that are not parallel to the intake direction. The plurality of ramp-like elements are disposed in succession along a transverse direction; the transverse direction is perpendicular to the longitudinal direction and to the intake direction.

[0010] The burner comprises a manifold configured to feed the gas to the inlets of the first and second intake ducts of the ramp-like elements. More specifically, the manifold includes a plurality of nozzles; the inlets of the first and second intake ducts of the ramp-like elements are each disposed in proximity to a respective nozzle so as to receive the gas flowing out of the nozzle. Thus, for each ramp-like element, the manifold includes a first and a second nozzle (and in one or more embodiments, a third and/or a fourth and/or a fifth nozzle). The first and second intake ducts of the ramp-like elements are configured to suck the gas and primary air into their respective inlets by the Venturi effect. The gas flowing into each duct comes from the respective nozzle; the primary air enters the duct from a periphery of the inlet of the duct. Inside each Venturi tube, the primary air mixes with the gas; thus, at the outlet of each duct, there is a mixture of primary air and gas. It should be noted that the nozzles are preferably between 0.3 and 1.5 mm (for example, 0.8 mm) in diameter; that way, the ratio between the quantity of primary air and the quantity of gas sucked in by the Venturi tube is sufficiently high.

[0011] For each ramp-like element of the plurality, the burner comprises (at least) one respective diffuser. The diffuser is disposed at the outlet of the first and of the second intake duct. The diffuser defines a plurality of holes from which a flame is generated by combustion of the gas coming from the first and the second intake duct (that is, by reaction of the gas with the oxygen present in the primary air).

[0012] It should be noted that according to an aspect of this disclosure, the geometry of each ramp-like element is such as to cause a very large amount of air to flow into the ducts, so that combustion of the primary air and gas mixture occurs under hyperstoichiometric conditions at least in part of the working range (near the minimum power level), that is, with air in excess of the quantity ideally necessary for producing a complete combustive reaction. Thus, combustion occurs at a reduced temperature, thereby decreasing NO_x production even in the absence of a water cooling system. In particular, a ratio between a width of the outlet of each first and second intake duct of each ramp-like element, along the transverse direction, divided by a pitch, along the transverse direction, between a first ramp-like element and a second, consecutive ramp-like element, is greater than 0.15 (or 0.16, or 0.17, or 0.18); preferably, greater than 0.2 or 0.25; still more preferably, greater than 0.3 or 0.35 or 0.4. It should be noted that by "pitch" is meant the distance between two homologous points of two consecutive ramp-like elements (in particular, of the first and second consecutive ramp-like elements). Thus, the width of the outlet of the first and second intake duct of each ramp-like element (also called width under-head) along the transverse direction, is greater than that of the prior art burners and this allows a larger quantity of primary air to flow in, with beneficial effects in terms of NO_x production.

[0013] For example, the width under-head may be 6 mm (preferably, this width is constant along the longitudinal direction), with a pitch of 17 mm between the first and the second ramp-like element; that way, the ratio is 0.353. In this example, NO_x production in the experimental tests conducted was 96 mg/kWh, as compared to 118 mg/kWh in the prior art with a ratio of 0.17 (obtained with a width under-head of 2.9 mm and a pitch of 17 mm between the first and the second ramp-like element). Thus, the tests conducted showed an improvement in terms of NO_x production when the width under-head was increased and hence, when the ratio between the width under-head and the pitch between two consecutive ramp-like elements was increased.

[0014] It should be noted that, preferably, a ratio between the maximum (or nominal) thermal power of the burner and the sum of the open cross section areas of the outlets of the ramp-like elements is between 3 and 6 W/mm^2, preferably between 4 and 5 W/mm^2; for example, in a burner with a maximum (or nominal) thermal power of 35 kW and 17 burner elements, each having an open cross section area of the outlets (of the first and second ducts) of 441 mm^2, the ratio between the maximum thermal power and the sum of the open cross section areas of the outlets of the ramp-like elements will be 4.27 W/mm^2.

[0015] According to a further aspect of this disclosure, between the first and second consecutive ramp-like elements, the burner defines an opening (or slot) for the inflow of secondary air to the diffuser. The secondary air flows to the diffuser through that opening, on the outside of the ducts of the ramp-like elements. More specifically, the burner comprises a plate positioned between the first and second consecutive ramp-like elements. The plate defines (or includes) the opening for the passage (or inflow) of secondary air. Preferably, the burner comprises a plurality of openings, one between each pair of consecutive ramp-like elements. More specifically, the burner comprises a plurality of plates, that is to say, for each pair of consecutive ramp-like elements, it comprises a respective plate defining a respective opening for the passage of secondary air and positioned between the ramp-like elements of the pair.

[0016] The plate (or each plate) for the secondary air is oriented parallel to the transverse direction; more specifically, it is oriented perpendicularly to the extension plane of the ramp-like elements. The opening allows secondary air to flow through along the intake direction; thus, the secondary air flows to the diffuser following a path having at least one component that is parallel to the intake direction. The opening defined in the plate (or in each plate) is elongate in shape along the longitudinal direction. One or more lateral openings may also be defined between a lateral edge of the plate and a wall of the ramp-like element; these one or more lateral openings are preferably elongate in shape along the longitudinal direction. These lateral openings allow lowering the temperature of the heads, thus avoiding problems caused by the heads becoming red and incandescent.

[0017] It should be noted that for each of the first and second consecutive ramp-like element, the diffuser is elongated along the longitudinal direction and defines (at least) one respective row of holes disposed in succession along the longitudinal direction. The opening for the passage of secondary air has a length which, in the longitudinal direction, is at least equal to the length of the row of holes in the longitudinal direction.

[0018] The plates for dividing the secondary air have beneficial effects in terms of NO_x emissions because they lower the temperature of the diffuser (not only because the inflow of secondary air lowers the temperature of combustion but also because the plates act as heat dissipation fins). However, it makes the flames more volatile and thus worsens flame stability, thereby increasing the tendency of the flame to be detached from the burner. In effect, the lower temperature of combustion results in less heating of the head (that is, lower specific energy) which may lead to the flame being detached from the burner and appearing at a certain distance from the gas outlet holes. This phenomenon is known as flame detachment and is particularly evident at low powers. The consequences may be incomplete fuel combustion or even possible extinguishment of the flame; incomplete combustion is particularly undesirable in that it increases the production of carbon monoxide. Thus, in the absence of counteractive features, the plates for the secondary air, although beneficial in terms of No_x emissions, decrease the possibility of modulating the burner, especially at low powers.

[0019] According to an aspect of this disclosure, the manifold comprises a first manifold portion, configured to feed the gas to a first group of ramp-like elements, and a second manifold portion, configured to feed the gas to a second group of ramp-like elements, different from the first group. The manifold comprises a partition for separating the first manifold portion from the second manifold portion. The partition is preferably fixed but it might also be movable. The gas can therefore be fed to the first and the second group of ramp-like elements independently of each other. That way, when the burner needs to be adjusted to a low power, the gas can be fed to only one of the manifold portions; thus, only some of the ramp-like elements of the plurality of ramp-like elements are fed with gas, thereby lowering the power of the burner while keeping the flame alive and stable in the ramp-like elements that are being fed with gas. In effect, the power is lowered not by reducing the speed of flame propagation which, as mentioned above, would lead to flame detachment, but by reducing the number of ramp-like elements that are kept alight. This is particularly advantageous when the plates for dividing the secondary air are provided, because these tend to increase the burner's tendency towards flame detachment, but it is also useful when no such plates are provided because it still allows the burner to work at low power without modifying the operating state of the individual ramp-like elements that remain alight.

[0020] More specifically, the manifold comprises a gas feed valve, connected to the first gas fitting and to the second gas fitting; the gas feed valve is positioned upstream of the first and second gas fittings and regulates the flow of gas to the fittings. More specifically, the gas feed valve is operable to a closed position, where it stops the gas flow to the manifold (that is, to both manifold portions), to a partly open position, where it allows the gas flow to only one between the first and the second manifold portion (through the respective gas fitting), and to a fully open position where it allows the gas flow to both the first and the second manifold portion (through the respective gas fittings). The burner comprises a control unit; the control unit is configured to receive an information item representing a thermal power request from a user. The control unit is configured to drive the gas feed valve to the closed position, to the open position or to the partly open position as a function of the thermal power request received from a user.

[0021] It should be noted that the manifold might also include a third and/or a fourth gas fitting (and others, where necessary) connected to the respective third and/or fourth manifold portion; what is described above in connection with the first and/or the second gas fitting also applies, with the necessary changes made, to the third and/or the fourth gas fitting (and any others, where necessary).

[0022] According to an aspect of this disclosure, each diffuser defines a first row of holes and a second row of holes; the holes of the first row and of the second row are disposed in succession along the longitudinal direction; the holes of the second row are distinct and separate from the holes of the first row. In other words, the first and second rows are separate from, and parallel to, each other. The first row of holes and the second row of holes extend along the outlet of the first and of the second intake duct, preferably uninterruptedly. This arrangement of the holes improves flame stability, especially at reduced powers.

[0023] According to an aspect of this disclosure, each ramp-like element has a first and a second upper end, opposite to each other along the longitudinal direction, and disposed at an upper end along the intake direction. By upper end is meant the end of each ramp-like element, relative to the intake direction, provided with the outlets of the ducts into which the gas is sucked. The respective diffuser is supported on the first and second upper ends. In an example embodiment, an upper central zone of the ramp-like element, located at the upper end and included (interposed) between the first and second upper ends, is offset from (specifically, lower than) the first and second upper ends along the intake direction; thus, a gap is formed along the intake direction between the diffuser and the upper central zone. More specifically, the gap is formed between a wall of the diffuser on which the holes are made, and the upper central zone of the ramp-like element. The gap is preferably at least 2 mm in size. In other words, the diffuser is supported on the first and second end but not on the upper central zone. This feature is beneficial in terms of reducing No_x production. In other embodiments, the gap is not provided (that is, it is 0 mm).

[0024] This disclosure also provides a boiler comprising a combustion chamber and a burner according to one or more aspects of this disclosure. The boiler may be of open chamber type or of closed chamber type (that is, provided with a fan to extract the combustion fumes).

[0025] This disclosure also provides a method for burning gas. The method comprises a step of preparing a plurality of ramp-like elements; the ramp-like elements are made according to one or more aspects of this disclosure; more specifically, the ramp-like elements are oriented parallel to each other and are disposed in succession along a transverse direction perpendicular to the extension plane of the ramp-like elements. For each ramp-like element of the plurality, the method comprises preparing a respective diffuser. The diffuser is disposed at the outlet of the first and of the second intake duct (so it covers the outlet of the first and of the second intake duct). The diffuser is made according to one or more aspects of this disclosure.

[0026] The method comprises a step of feeding the gas through a manifold to the inlet of the first and the second intake duct (and, if provided, of the third and/or the fourth and/or the fifth intake duct) of the plurality of ramp-like elements. The manifold is made according to one or more aspects of this disclosure.

[0027] The method comprises a step of sucking the gas and primary air into the first and the second intake duct of the plurality of ramp-like elements by the Venturi effect.

[0028] The method comprises, for each of the plurality of ramp-like elements, a step of generating a flame from the holes of the respective diffuser through combustion of the gas coming from the first and the second intake duct. The flame can be lit using a lighter disposed in the proximity of the diffuser.

[0029] The method preferably comprises a step of feeding secondary air through an opening defined in a plate positioned between a first and a second consecutive ramp-like element of the plurality of ramp-like elements.

[0030] The method may comprise a step of selectively feeding the gas to a first portion of the manifold, configured to feed the gas to a first group of ramp-like elements, or to a second portion of the manifold, configured to feed the gas to a second group of ramp-like elements, different from the first group. The first manifold portion is separate from the second portion. More specifically, the method may comprise a step of controlling a gas feed valve to drive it to a closed position, where it stops the gas flow to the manifold, to a partly open position, where it allows the gas flow to only one between the first and the second manifold portion, and to a fully open position where it allows the gas flow to both the first and the second manifold portion.

[0031] Thus, this disclosure provides a number of possible features to reduce No_x emissions and, at the same time, to avoid flame detachment. These features may be adopted individually or in combination. Shown below by way of example are the results of experimental tests conducted on the burner of this disclosure. The experimental tests were conducted using as reference gas a fuel gas of what is known as the second family, that is to say, gas consisting of 100% methane (denoted by the label G20 in European regulations). To start with, we used a burner with 17 ramp-like elements of the type described in document WO2016/193904 in the name of the present Applicant, without a cooling system; the pondered quantity of No_x initially produced was 137 mg/kWh. The size of the nozzles was then reduced to 0.8 mm, thus obtaining a pondered quantity of No_x of 128 mg/kWh. Next, the open cross section of the burner head was increased to 441 mm^2; thanks to this modification, we obtained a pondered quantity of No_x of 118 mg/kWh. Next, we increased the width of the outlets of the first and second intake ducts to 6 mm; thanks to this modification, we obtained a pondered quantity of No_x of 96 mg/kWh. Next, we lowered the central zone of the upper end of the ramp-like element, thereby obtaining a pondered quantity of No_x of 92 mg/kWh. We noticed that the benefits of these modifications in terms of No_x production were counterbalanced by a worsening of burner behaviour in terms of flame detachment (causing a 30 ppm increase in carbon monoxide production, starting from an initial 340 ppm). We then implemented the plates for dividing the secondary air and provided two separate gas fittings; thanks to these measures, we observed that the pondered quantity of No_x dropped to 57 mg/kWh and carbon monoxide dropped to 418 ppm.

[0032] These and other features will become more apparent from the following detailed description of a preferred embodiment, illustrated by way of non-limiting example in the accompanying drawings, in which:

- Figure 1 shows a burner according to one or more aspects of this disclosure, in a perspective view;
- Figure 2 shows the burner of Figure 1, in another perspective view;
- Figure 3 shows the burner of Figure 1, in a top view;
- Figure 4 shows the burner of Figure 1, in a side view;
- Figures 5 and 6 show three ramp-like elements of the burner of Figure 1, with respective diffusers and respective plates for the secondary air;
- Figures 7 and 8 show a single ramp-like element of the burner of Figure 1;
- Figure 9 shows a plate for the secondary air of the burner of Figure 1;
- Figures 10A and 10B show respective embodiments of a diffuser of the burner of Figure 1.

[0033] With reference to this disclosure, the numeral 1 denotes a burner. The burner 1 comprises a plurality of ramp-like elements 2. The ramp-like elements 2 are oriented along respective extension planes parallel to a longitudinal direction L and to an intake direction A. The intake direction A is at right angles to the longitudinal direction L. The ramp-like elements 2 are disposed side by side along a transverse direction T. The transverse direction T is at right angles to the longitudinal direction L and to the intake direction A.

[0034] Each ramp-like element 2 includes a first intake duct 21 and a second intake duct 22. The first and second intake ducts 21, 22 are shaped like Venturi tubes, that is to say, they include a convergent portion and, downstream of the convergent portion, a divergent portion. The first and the second intake duct 21, 22 have a respective inlet 21A, 22A and a respective outlet 21B, 22B. The first and the second intake duct 21, 22 are oriented along a direction having at least one component that is parallel to the intake direction A; in an embodiment, they are oriented along a direction parallel to the intake direction A. Thus, the inlet 21A of the first duct is offset from the outlet 21B of the first duct along the intake direction A; similarly, the inlet 21B of the second duct is offset from the outlet 21B of the second duct along the intake direction A.

[0035] In the accompanying drawings, the letter P denotes a pitch between a pair of consecutive ramp-like elements 2; the pitch P is the distance between two homologous points of the pair of consecutive ramp-like elements 2. Preferably, the pitch may be between 15 and 20 mm (for example, 17 mm). The burner 1 comprises a manifold 3 configured to feed the gas to the inlets 21A, 21B of the first and second intake ducts 21, 22 of the ramp-like elements 2. More specifically, the manifold 3 comprises a first conduit 31 and a second conduit 32, oriented in the transverse direction T and parallel to each other. The conduits 31 and 32 are each provided with a plurality of nozzles 33. Each nozzle 33 is positioned at the inlet of one of the intake ducts. More specifically, the nozzles 33 of the first conduit 31 are positioned in proximity to respective inlets 21A of the first ducts 21 and the nozzles 33 of the second conduit 32 are positioned in proximity to respective inlets 22A of the second ducts 22. The first conduit 31 and the second conduit 32 are each divided into a first part and a second part by an internal partition. The first part of the first conduit 31 and the first part of the second conduit 32 thus form a first portion 36 of the manifold 3 to feed a first group 2A of ramp-like elements 2. The second part of the first conduit 31 and the second part of the second conduit 32 form a second portion 37 of the manifold 3 to feed a second group 2B of ramp-like elements 2. The manifold 3 also includes a first gas fitting 34, connected to the first portion 36 of the manifold 3, and a second gas fitting 35, connected to the second portion 37 of the manifold 3. The first gas fitting 34 and the second gas fitting 35 can be fed independently of each other.

[0036] The burner 1 comprises a plurality of diffusers 4. Each diffuser 4 is positioned at the outlet 21B, 22B of the first and the second intake duct 21, 22 of a respective ramp-like element 2. Each diffuser 4 covers both the outlet 21B of the first intake duct 21 and the outlet 22B of the second intake duct 22. Each diffuser 4 defines a plurality of holes 40 from which the flame is generated. The holes 40 are disposed in at least one ordered row along the longitudinal direction L. More specifically, in an embodiment, the holes 40 are disposed along a first row 40A and a second row 40B, oriented along the longitudinal direction L and parallel to each other; in this embodiment, the holes 40 of the first row 40A are separate from the holes 40 of the second row 40B.

[0037] It should be noted that each ramp-like element 2 has a first and a second upper end 20A, 20B; the first and the second upper end 20A, 20B are located on an upper side of the burner 1, opposite one another. By upper side is meant the side which, if the burner 1 is positioned so that the flame extends vertically (that is, along the intake direction A), is located at a greater vertical height. The diffuser 4 is fixed to the first and second upper ends 20A, 20B. The upper side is variable in height along the intake direction A. More specifically, the first and second upper ends 20A, 20B are raised relative to the upper central zone which delimits the outlets 21B, 22B of the first and second intake ducts 21, 22. An offset along the intake direction A, between the first (or the second) upper end 20A (20B) and the upper central zone, is labelled D2. Thanks to this offset D2, the wall of the diffuser 4 on which the holes 40 are defined does not rest on the upper central zone and a gap is thus formed between the wall of the diffuser 4 and the upper central zone of the ramp-like element 2.

[0038] It should be noted that a width of the outlet 21B, 22B of each first and second intake duct 21, 22 of each ramp-like element 2, along the transverse direction T, is labelled D1. The width D1 is preferably equal for the first and for the second intake duct 21, 22. The width D1 is greater than a respective minimum value; thus, the ratio between the width D1 and the pitch P, between a first ramp-like element 2 and a second, consecutive ramp-like element 2 is also greater than a respective minimum value (0.15, or 0.2, or 0.25, or 0.3). Preferably, the ratio between D1 and the maximum width of the plate 5, in the transverse direction T, is between 0.4 and 0.6 (for example, it may be 0.5, where D1 is 6 mm and the width of the plate 5 is 12 mm). Preferably, a ratio between a sum of a flow-through cross section of the outlet 21B of the first intake duct 21 plus a flow-through cross section of the outlet 22B of the second intake duct 22, divided by a pitch P, along the transverse direction T, between a first ramp-like element 2 and a second, consecutive ramp-like element 2, is between 40 and 60 (or between 45 and 55, or between 50 and 55). In calculating this ratio, the cross section may be expressed in mm^2 and the pitch in mm. By flow-through cross section is meant the cross section having width D1. For example, the sum of the flow-through cross sections might be 899 mm^2, and the pitch 17 mm, so the ratio as defined above is 52.9.

[0039] Preferably, a ratio between a sum of a minimum flow-through cross section of the first intake duct 21 plus a minimum flow-through cross section of the second intake duct 22, divided by a pitch P, along the transverse direction T, between a first ramp-like element 2 and a second, consecutive ramp-like element 2, is between 8 and 15 (or between 9 and 14, or between 10 and 13). In calculating this ratio, the cross section may be expressed in mm^2 and the pitch in mm. Preferably, the minimum cross section of the intake ducts 21, 22 is defined in a stretch of the ducts oriented parallel to the intake direction; this stretch preferably defines a zone 202 with constant cross section. For example, the sum of the minimum flow-through cross sections of the first and second ducts might be 190 mm^2, and the pitch 17 mm, so the ratio as defined above is 11.2.

[0040] The burner 1 comprises a plurality of plates 5. Each plate 5 is interposed between a pair of adjacent ramp-like elements 2. Each plate 5 is oriented in a plane parallel to the longitudinal direction L and to the transverse direction T. Each plate 5 defines an opening 50 to divide the secondary air. The opening 50 has an axis which is parallel to the intake direction A; in other words, the opening 50 allows the secondary air to flow through along the intake direction A. Each plate 5 has a first face directed towards the inlets 21A, 22A of the first and second intake ducts 21 and 22, and a second face opposite the first face and directed towards the outlets 21B, 22B of the first and second intake ducts 21 and 22. The opening 50 is located in a central zone of the plate 5, equidistant from the two ramp-like elements 2 adjacent to the plate 5, and is elongate in shape along the longitudinal direction L. Preferably, the opening 50 is constant in width along the transverse direction T. The length of the opening 50 in the longitudinal direction L is (at least) equal to the length of a row of holes 40 of the diffuser 4; that way, the secondary air can flow uniformly along the flame. A ratio between the width of the opening 50 in the transverse direction T and a (maximum) width of the plate 5, in the transverse direction T, is preferably between 0.05 and 0.1; for example, it may be 0.083 (where the width of the opening 50 is 1 mm and the maximum width of the plate 5 is 12 mm).

[0041] It should be noted that each plate 5 is preferably not constant in width in the transverse direction T; in effect, at least at a first end and at a second end, opposite the first end, the plate 5 has a first width (or maximum width) and, in a zone between the first end and the second end, a second width, smaller than the first width. A portion with the first width might also be present in a central zone, between the first and the second end (preferably equidistant from the first and the second end); in this case, the plate 5 has the first width at a first end of it, in the central zone, and the second width, which is smaller than the first width, at a second of it, in intermediate zones between the first end and the central zone and between the central zone and the second end. A ratio between the first width and the second width may be between 1.1 and 1.3 (for example, it may be 1.2); for example, the first width of the plate 5 may be 12 mm and the second width, 10 mm. The zones having the first width, located at the first end, in the central zone and at the second end, each have a length, along the longitudinal direction L, of between 0.01 and 0.05 (for example, 0.03) multiplied by the total length of the plate 5 in the longitudinal direction L. For example, the plate 5 may be 155 mm long in the longitudinal direction L and each of the zones with the first width may be 5 mm long in the longitudinal direction L.

[0042] Thus, between the edge of the plate 5, in the zone having the second width, and the wall of the ramp-like element 2, additional openings (or side openings) 51 are defined. The additional openings 51 are elongate in shape in the longitudinal direction. The additional openings 51 are useful for cooling the heads.

[0043] This shape improves heat dissipation from the diffuser 4 through the plate 5. The burner 1 comprises a frame on which the ramp-like elements 2 and the manifold 3 are mounted. The frame comprises a first side bracket 61A and a second side bracket 61B, between which the ramp-like elements 2 are positioned. More specifically, the first side bracket 61A is connected to a first ramp-like element 2 and the second side bracket 61B is connected to a last ramp-like element 2 of the succession of ramp-like elements 2. The other ramp-like elements 2 are positioned between the first and the last ramp-like element 2 and are connected to each other. The frame also includes a first connecting element 62A and a second connecting element 62B. The first connecting element 62A is connected to the first side bracket 61A and defines an opening that houses a first end of the manifold 3. The second connecting element 62B is connected to the second side bracket 61B and defines an opening that houses a second end of the manifold 3, opposite to the first end.

[0044] It should be noted that, preferably, a ratio between an area occupied by the outlets of the first and the second intake duct 21, 22, divided by the pitch P, is between 55 and 70 (or between 60 and 65). By "area occupied" is meant the sum of the flow-through cross section plus the thickness of the duct walls. For example, the area occupied might be 1094 mm^2 and the pitch, 17 mm, so the ratio defined above is 64.4.

[0045] It should be noted that each intake duct 21, 22 preferably includes a first zone 201, having a convergent cross section, a second zone 202, connected to the first zone 201 and having a constant cross section (the second zone is preferably oriented vertically), a third zone 203, connected to the second zone 202 and having a divergent cross section, a fourth zone 204, connected to the third zone and also having a divergent cross section, inclined to the intake direction A at a larger angle than the third zone 203, and a fifth zone 205, connected to the fourth zone and having a constant cross section, defining the outlet of the ducts. The fifth zone 205 may also be called zone under-head. Preferably, a ratio between a sum of a cross section of the first duct 21 plus a cross section of the second duct 22, in the zone of interconnection between the third zone 203 and the fourth zone 204, divided by the pitch P, is between 20 and 30 (or between 24 and 28). For example, the sum of a cross section of the first duct 21 and a cross section of the second duct 22, in the zone of interconnection between the third zone and the fourth zone, might be 452 mm and the pitch, 17 mm, so the ratio is 26.6.

[0046] It should be noted that the holes 40 of each diffuser are inscribed in a rectangle. Preferably, a ratio between the area of the rectangle circumscribing the holes 40 and the pitch P is between 50 and 70 (or between 55 and 65). For example, the area of the rectangle might be 988 mm^2 and the pitch, 17 mm, so this ratio is 58.1.

[0047] Preferably, a ratio between the sum of the cross sections of the holes 40 of the plurality of holes 40, divided by the pitch P, is between 22 and 30 (or between 23 and 26). For example, the sum of the cross sections of the holes 40 might be 419 mm, and the pitch 17 mm, so this ratio is 24.6.

[0048] A ratio between the sum of the cross sections of the holes 40 of the plurality of holes, divided by the rectangle circumscribing the holes 40, defines the porosity of each diffuser 4. Preferably, a porosity of each diffuser 4 is between 0.35 and 0.43 (or between 0.4 and 0.42).

[0049] The following paragraphs, listed in alphanumeric order for reference, are non-limiting example modes of describing this invention.

[0050] A. A module for a gas burner, comprising:

- a ramp-like element (2), disposed along a respective extension plane, parallel to a longitudinal direction (L) and to an intake direction (A) and including a first intake duct (21) and a second intake duct (22), having a respective inlet (21A, 22A) and an outlet (21B, 22B), wherein the first and the second intake duct (21, 22) are oriented in the extension plane of the respective ramp-like element (2);
- a diffuser (4), disposed at the outlet (21B, 22B) of the first and of the second intake duct (21, 22), and defining a plurality of holes (40) from which a flame is generated by combustion of the gas coming from the first and the second intake duct (21, 22).

[0051] A1. The module according to paragraph A, wherein the first and the second intake duct (21, 22) extend between the inlet (21A, 22A) and the outlet (21B, 22B) along a direction having at least one component that is parallel to the intake direction (A).

[0052] A2. The module according to paragraph A or paragraph A1, wherein the diffuser (4) extends along the longitudinal direction (L) and defines a first row (40A) of holes (40) and a second row (40B) of holes (40), disposed in succession along the longitudinal direction (L), wherein the holes (40) of the second row (40B) are distinct and separate from the holes (40) of the first row (40A).

[0053] A2.1. The module according to paragraph A2, wherein the first row (40A) of holes 40 and the second row (40B) of holes (40) extend along the outlet (21B, 22B) of the first and of the second intake duct (21, 22) for the full length of the outlet along the longitudinal direction (L).

[0054] A3. The module according to any one of paragraphs A to A2.1, wherein each ramp-like element (2) has a first and a second upper end (2A, 2B), opposite to each other along the longitudinal direction (L), and disposed at an upper end along the intake direction (A), wherein the respective diffuser (4) is supported on the first and second upper ends, and wherein an upper central zone of the ramp-like element (2), included between the first and second upper ends (2A, 2B), is lower down, along the intake direction (A), than the first and second upper ends (2A, 2B), thus defining, along the intake direction (A), a gap between the diffuser (4) and the upper central zone.

[0055] A4. The module according to any one of paragraphs A to A3, wherein a ratio between a maximum (or nominal) thermal power produced by the combustion of the gas and a total outlet cross section of the first and second ducts of the ramp-like element (2) is between 2 and 6 (preferably between 3 and 5).

[0056] A5. The module according to any one of paragraphs A to A4, wherein each ramp-like element of the plurality of ramp-like elements (2) has a respective outlet (21B, 22B).

[0057] A6. The module according to any one of paragraphs A to A4, wherein the plurality of ramp-like elements (2) has a common outlet.

[0058] A7. The module according to any one of paragraphs A to A6, wherein the intake direction (A) is vertical.

[0059] A7.1. The module according to paragraph A7, wherein the inlets (21A, 22A) and the outlets (21B, 22B) of the intake ducts (21) are oriented vertically. A7.2. The module according to any one of paragraph A7 or A7.1, wherein the manifold (3) is located at a lower quote than the intake ducts (21) and the inlets (21A, 22A) are positioned over the manifold (3).

[0060] A8. The module according to any one of paragraphs A to A7.2, wherein the longitudinal direction (L) is orthogonal to the intake direction (A).

[0061] A9. The module according to any one of paragraphs A to A8, wherein the first and the second intake duct (21, 22) and are spaced from each other along a predetermined direction.

[0062] A9.1. The module according to any one of paragraph A9, wherein the predetermined direction is the longitudinal direction (L).

[0063] A10. The module according to any one of paragraphs A to A9.1, wherein the first and the second intake duct (21, 22) and are spaced from each other vertically.

[0064] A10.1. The module according to paragraph A10, wherein the manifold (3) is located at a side of the intake ducts (21).

[0065] A10.2. The module according to any one of paragraph A10 or A10,1, wherein the inlets (21A, 22A) are oriented along the longitudinal direction (L) and the outlet (21B, 22B) or outlets (21B, 22B) are oriented vertically.

[0066] B. A burner comprising a plurality of modules according to any one of paragraphs from A to A10, wherein the plurality of ramp-like elements (2) are disposed in succession along a transverse direction (T) perpendicular to the longitudinal direction (L) and to the intake direction (A).

[0067] B1. The burner according to paragraph B, comprising a manifold (3), configured to feed the gas to the inlets of the first and second intake ducts (21, 22) of the plurality of ramp-like elements (2), wherein the first and second intake ducts (21, 22) of the plurality of ramp-like elements (2) are configured to suck the gas and primary air into their respective inlets (21A, 22A) by the Venturi effect.

[0068] B2. The burner according to paragraph B or paragraph B1, wherein a ratio between a width of the outlet (21B, 22B) of each first and second intake duct (21, 22) of each ramp-like element (2), along the transverse direction (T), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is greater than 0.15 (preferably greater than 0.2, and still more preferably, greater than 0.3 or 0.35).

[0069] B3. The burner according to any one of paragraphs B to B2, wherein a ratio between a sum of a flow-through cross section of the outlet (21B) of the first intake duct (21) plus a flow-through cross section of the outlet (22B) of the second intake duct (22), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is between 40 and 60 (or between 45 and 55, or between 50 and 55).

[0070] B4. The burner according to any one of paragraphs B to B3, wherein a ratio between a sum of a minimum flow-through cross section of the first intake duct (21) plus a minimum flow-through cross section of the second intake duct (22), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is between 8 and 15 (or between 9 and 14, or between 10 and 13).

[0071] B5. The burner according to any one of paragraphs B to B4, comprising an opening (50) for the passage of secondary air between a first and a second, consecutive ramp-like element (2).

[0072] B5.1. The burner according to paragraph B5, comprising a plate (5) positioned between the first and second consecutive ramp-like elements (2), wherein the plate defines an opening (50) for the passage of secondary air. B5.1.1. The burner according to paragraph B5.1, wherein the plate (5) is oriented parallel to the transverse direction (T).

[0073] B5.2. The burner according to any one of paragraphs B5 to B5.1.1, wherein the opening (50) allows the secondary air to flow through along the intake direction (A) and/or extends along the longitudinal direction (L).

[0074] B5.3. The burner according to any one of paragraphs B5 to B5.3, comprising, for each pair of consecutive ramp-like elements (2) of the plurality of ramp-like elements (2), a respective plate (5) and a respective opening (50) for the passage of secondary air and positioned between the ramp-like elements (2) of the pair.

[0075] B6. The burner according to any one of paragraphs B to B5.3, wherein the manifold (3) comprises a first manifold portion (36), configured to feed the gas to a first group (2A) of ramp-like elements (2), and a second manifold portion (37), configured to feed the gas to a second group (2B) of ramp-like elements (2), different from the first group (2A), and wherein the burner (1) comprises a first fitting (34) to feed the gas to the first manifold portion (36) and a second fitting (35) to feed the gas to the second manifold portion (37). B6.1. The burner according to paragraph B6, comprising a gas feed valve, connected to the first gas fitting (34) and to the second gas fitting (35), and operable to a closed position, where it stops the gas flow to the manifold (3), to a partly open position, where it allows the gas flow to only one between the first and the second manifold portion (36, 37), and to a fully open position where it allows the gas flow to both the first and the second manifold portion (36, 37).

[0076] B6.1.1. The burner according to paragraph B6.1, comprising a control unit, configured to drive the gas feed valve to the closed position, to the open position or to the partly open position as a function of a thermal power request received from a user.

[0077] B7. The burner according to any one of paragraphs B to B6.1.1, wherein the burner is air cooled.

[0078] C. A boiler comprising a combustion chamber and a burner (1) according to any one of the preceding paragraphs.

[0079] D. A method for burning gas, comprising the following steps:

- preparing a plurality of ramp-like elements (2), each of which is disposed along a respective extension plane, parallel to a longitudinal direction (L) and to an intake direction (A) and includes a first intake duct (21) and a second intake duct (22), having a respective inlet (21A, 22A) and an outlet (21B, 22B), wherein the first and the second intake duct (21, 22) are oriented in the extension plane of the respective ramp-like element (2), and wherein the plurality of ramp-like elements (2) are disposed in succession along a transverse direction (T) perpendicular to the longitudinal direction (L) and to the intake direction (A);
- for each of the plurality of ramp-like elements (2), preparing a respective diffuser (4), disposed at the outlet (21B, 22B) of the first and of the second intake duct (21, 22), and defining a plurality of holes (40);
- feeding the gas to the inlet (21A, 21B) of the first and the second intake duct (21, 22) of the plurality of ramp-like elements (2) through a manifold (3),
- sucking the gas and primary air into the first and the second intake duct (21, 22) of the plurality of ramp-like elements (2) by the Venturi effect,
- for each of the plurality of ramp-like elements (2), generating a flame from the holes (40) of the respective diffuser (4) through combustion of the gas coming from the first and the second intake duct (21, 22).

[0080] D1. The method according to paragraph D, wherein a ratio between a width of the outlet (21B, 22B) of each first and second intake duct (21, 22) of each ramp-like element (2), along the transverse direction (T), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is greater than 0.15 (preferably greater than 0.2, and still more preferably, greater than 0.3).

[0081] D2. The method according to paragraph D or D1, wherein a ratio between a sum of a flow-through cross section of the outlet (21B) of the first intake duct (21) plus a flow-through cross section of the outlet (22B) of the second intake duct (22), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is between 40 and 60 (or between 45 and 55, or between 50 and 55).

[0082] D3. The method according to any one of paragraphs D to D2, wherein a ratio between a sum of a minimum flow-through cross section of the first intake duct (21) plus a minimum flow-through cross section of the second intake duct (22), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is between 8 and 15 (or between 9 and 14, or between 10 and 13).

[0083] D4. The method according to any one of paragraphs D to D3, comprising a step of feeding secondary air through an opening (50) or slot defined between a first and a second consecutive ramp-like element (2) of the plurality of ramp-like elements (2).

[0084] D4.1. The method according to paragraph D4, wherein the opening (50) is defined in a plate (5) positioned between the first and second consecutive ramp-like elements (2).

[0085] D4.1.1. The method according to paragraph D4.1, wherein the opening (50) extends along the longitudinal direction (L).

[0086] D5. The method according to any one of paragraphs D to D4.1.1, wherein the manifold (3) comprises a first manifold portion (36), configured to feed the gas to a first group (2A) of ramp-like elements (2), and a second manifold portion (37), configured to feed the gas to a second group (2B) of ramp-like elements (2), different from the first group (2A), and wherein the method comprises a step of selectively feeding the gas to the first manifold portion (36) and/or to the second manifold portion (37).

[0087] D5.1. The method according to paragraph D5, wherein the step of selectively feeding comprises controlling a gas feed valve to drive it to a partly open position, where it allows gas to flow to only one between the first and the second manifold portion (36, 37), to a fully open position where it allows the gas flow to the first and the second manifold portion (36, 37), as a function of a thermal power request received from a user.

[0088] D6. The method according to any one of paragraphs D to D5.1, comprising a step of air cooling, that is to say, wherein water cooling is not provided.

[0089] D7. The method according to any one of paragraphs D to D6, wherein each ramp-like element of the plurality of ramp-like elements (2) has a respective outlet (21B, 22B).

[0090] D8. The method according to any one of paragraphs D to D6, wherein the plurality of ramp-like elements (2) have a common outlet.

[0091] D9. The method according to any one of paragraphs D to D8, wherein the intake direction (A) is vertical.

[0092] D9.1. The method according to paragraph D9, wherein the inlets (21A, 22A) and the outlets (21B, 22B) of the intake ducts (21) are oriented vertically. D9.2. The method according to any one of paragraph D9 or D9.1, wherein the manifold (3) is located at a lower quote than the intake ducts (21) and the inlets (21A, 22A) are positioned over the manifold (3).

[0093] D10. The method according to any one of paragraphs D to D9.2, wherein the longitudinal direction (L) is orthogonal to the intake direction (A).

[0094] D11. The method according to any one of paragraphs D to D10, wherein the first and the second intake duct (21, 22) and are spaced from each other along a predetermined direction.

[0095] D11.1. The method according to paragraph D11, wherein the predetermined direction is the longitudinal direction (L).

[0096] D12. The method according to any one of paragraphs D to D11.1, wherein the first and the second intake duct (21, 22) and are spaced from each other vertically.

[0097] D12.1. The method according to paragraph D12, wherein the manifold (3) at a side of the intake ducts (21).

[0098] D12.2. The method according to any one of paragraph D12 or D12.1, wherein the inlets (21A, 22A) are oriented along the longitudinal direction (L) and the outlet (21B, 22B) or outlets (21B, 22B) are oriented vertically.

Claims

1. An air-cooled gas burner (1), comprising:

- a plurality of ramp-like elements (2), each of which is disposed along a respective extension plane, parallel to a longitudinal direction (L) and to an intake direction (A) and includes a first intake duct (21) and a second intake duct (22), having a respective inlet (21A, 22A) and an outlet (21B, 22B), wherein the first and the second intake duct (21, 22) are oriented in the extension plane of the respective ramp-like element (2) and are spaced from each other along the longitudinal direction (L), and wherein the plurality of ramp-like elements (2) are disposed in succession along a transverse direction (T) perpendicular to the longitudinal direction (L) and to the intake direction (A);

- a manifold (3), configured to feed the gas to the inlets (21A, 21B) of the first and second intake ducts (21, 22) of the plurality of ramp-like elements (2), wherein the first and second intake ducts (21, 22) of the plurality of ramp-like elements (2) are configured to suck the gas and primary air into their respective inlets (21A, 22A) by the Venturi effect;
- for each of the plurality of ramp-like elements (2), a respective diffuser (4), disposed at the outlet (21B, 22B) of the first and of the second intake duct (21, 22), and defining a plurality of holes (40) from which a flame is generated by combustion of the gas coming from the first and the second intake duct (21, 22),

2. The burner (1) according to claim 1, comprising a plate (5) positioned between the first and second consecutive ramp-like elements (2), wherein the plate defines an opening (50) for the passage of secondary air.

3. The burner (1) according to claim 2, wherein the plate (5) is oriented parallel to the transverse direction (T) and the opening (50) allows the secondary air to flow through along the intake direction (A) and extends along the longitudinal direction (L).

4. The burner (1) according to claim 2 or 3, wherein, for each of the first and second consecutive ramp-like elements (2), the diffuser (4) extends along the longitudinal direction (L) and defines a respective row of holes (40) disposed in succession along the longitudinal direction (L), wherein the opening (50) for the passage of secondary air has a length which, along the longitudinal direction (L), is at least equal to the length of the row of holes (40) along the longitudinal direction (L).

5. The burner (1) according to any one of claims 2 to 4, comprising, for each pair of consecutive ramp-like elements (2) of the plurality of ramp-like elements (2), a respective plate (5) defining a respective opening (50) for the passage of secondary air and positioned between the ramp-like elements (2) of the pair.

6. The burner (1) according to any one of the preceding claims, wherein one or more of the following conditions is met:

i) a ratio between a width (D1) of the outlet (21B, 22B) of each first and second intake duct (21, 22) of each ramp-like element (2), along the transverse direction (T), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is greater than 0.15;

ii) a ratio between a sum of a flow-through cross section of the outlet (21B) of the first intake duct (21) plus a flow-through cross section of the outlet (22B) of the second intake duct (22), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is between 40 and 60;

iii) a ratio between a sum of a minimum flow-through cross section of the first intake duct (21) plus a minimum flow-through cross section of the second intake duct (22), divided by a pitch (P), along the transverse direction (T), between a first ramp-like element (2) and a second, consecutive ramp-like element (2), is between 8 and 15.

7. The burner (1) according to any one of the preceding claims, wherein the first and the second intake duct (21, 22) of each ramp-like element (2) extend between the inlet (21A, 22A) and the outlet (21B, 22B) along a direction having at least one component that is parallel to the intake direction (A), wherein the intake direction (A) is vertical and the longitudinal direction (L) is orthogonal to the intake direction (A).

8. The burner (1) according to any one of the preceding claims, wherein the manifold (3) comprises a first manifold portion (36), configured to feed the gas to a first group (2A) of ramp-like elements (2), and a second manifold portion (37), configured to feed the gas to a second group (2B) of ramp-like elements (2), different from the first group (2A), and wherein the burner (1) comprises a first fitting (34) to feed the gas to the first manifold portion (36) and a second fitting (35) to feed the gas to the second manifold portion (37), wherein the burner (1) comprises a gas feed valve, connected to the first gas fitting (34) and to the second gas fitting (35), and operable to a closed position, where it stops the gas flow to the manifold (3), to a partly open position, where it allows the gas flow to only one between the first and the second manifold portion (36, 37), and to a fully open position where it allows the gas flow to both the first and the second manifold portion (36, 37).

9. The burner (1) according to any one of the preceding claims, wherein each diffuser (4) extends along the longitudinal direction (L) and defines a first row (40A) of holes (40) and a second row (40B) of holes (40), disposed in succession along the longitudinal direction (L), wherein the holes (40) of the second row (40B) are distinct and separate from the holes (40) of the first row (40).

10. The burner (1) according to any one of the preceding claims, wherein each ramp-like element (2) has a first and a second upper end (20A, 20B), opposite to each other along the longitudinal direction (L), and disposed at an upper end of the ramp-like element (2) along the intake direction (A), wherein the respective diffuser (4) is supported on the first and second upper ends, and wherein an upper central zone of the ramp-like element (2), interposed between the first and second upper ends (20A, 20B), is offset from the first and second upper ends (20A, 20B) along the intake direction (A), thus defining, along the intake direction (A), a gap between a wall of the diffuser (4), on which the holes are made, and the upper central zone.

11. The burner (1) according to any one of the preceding claims, wherein the first and the second intake duct (21, 22) in each ramp-like element (2) are geometrically symmetrical to each other.

12. The burner (1) according to any one of the preceding claims, wherein one of the following conditions is met:

i) each ramp-like element of the plurality of ramp-like elements (2) has a respective outlet (21B, 22B);
ii) the plurality of ramp-like elements (2) have a common outlet.

13. A boiler comprising a combustion chamber and a burner (1) according to any one of the preceding claims.

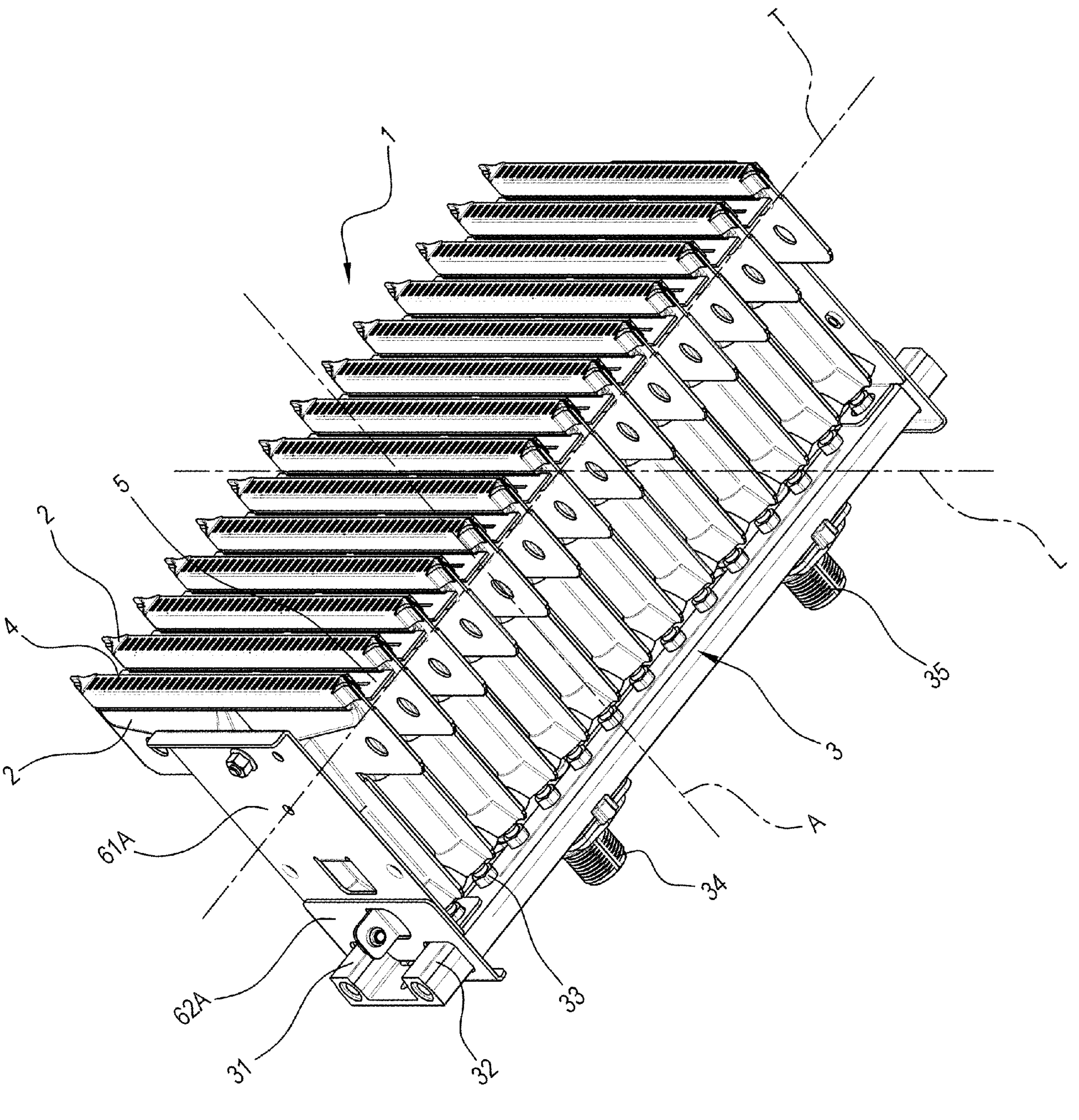
14. A method for burning gas, comprising the following steps:

- preparing an air-cooled gas burner (1), wherein the burner (1) comprises a plurality of ramp-like elements (2), each of which is disposed along a respective extension plane, parallel to a longitudinal direction (L) and to an intake direction (A) and includes a first intake duct (21) and a second intake duct (22), having a respective inlet (21A, 22A) and an outlet (21B, 22B), wherein the first and the second intake duct (21, 22) are oriented in the extension plane of the respective ramp-like element (2) and are spaced from each other along the longitudinal direction (L), and wherein the plurality of ramp-like elements (2) are disposed in succession along a transverse direction (T) perpendicular to the longitudinal direction (L) and to the intake direction (A);

wherein, the burner (1) further comprises, for each of the plurality of ramp-like elements (2), a respective diffuser (4), disposed at the outlet (21B, 22B) of the first and of the second intake duct (21, 22), and defining a plurality of holes (40);

- feeding the gas to the inlet (21A, 21B) of the first and the second intake duct (21, 22) of the plurality of ramp-like elements (2) through a manifold (3),
- sucking the gas and primary air into the first and the second intake duct (21, 22) of the plurality of ramp-like elements (2) by the Venturi effect,
- for each of the plurality of ramp-like elements (2), generating a flame from the holes (40) of the respective diffuser (4) through combustion of the gas coming from the first and the second intake duct (21, 22).

15. The method according to claim 14, comprising a step of feeding secondary air through an opening (50) defined in a plate (5) positioned between a first and a second consecutive ramp-like element (2) of the plurality of ramp-like elements (2).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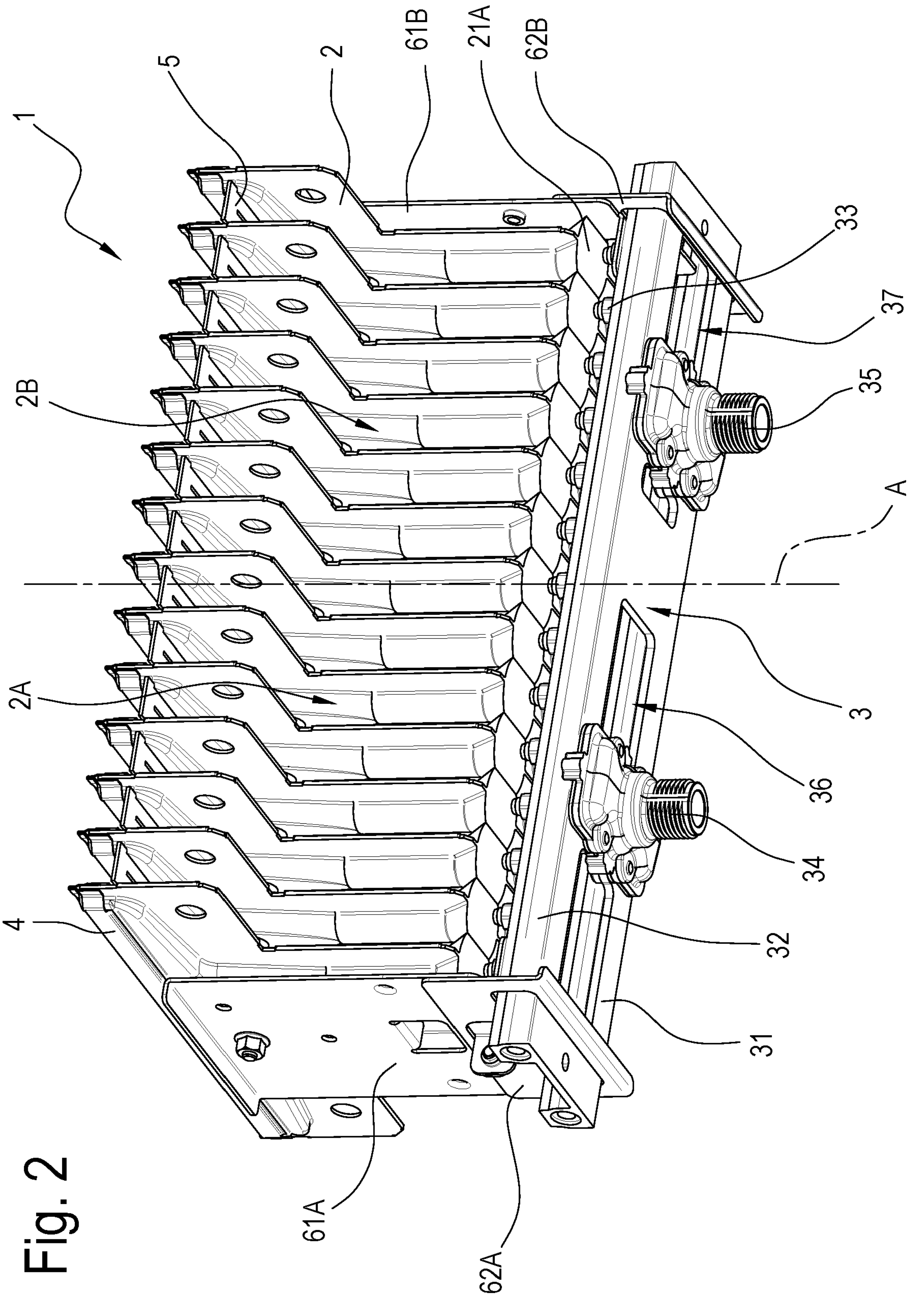
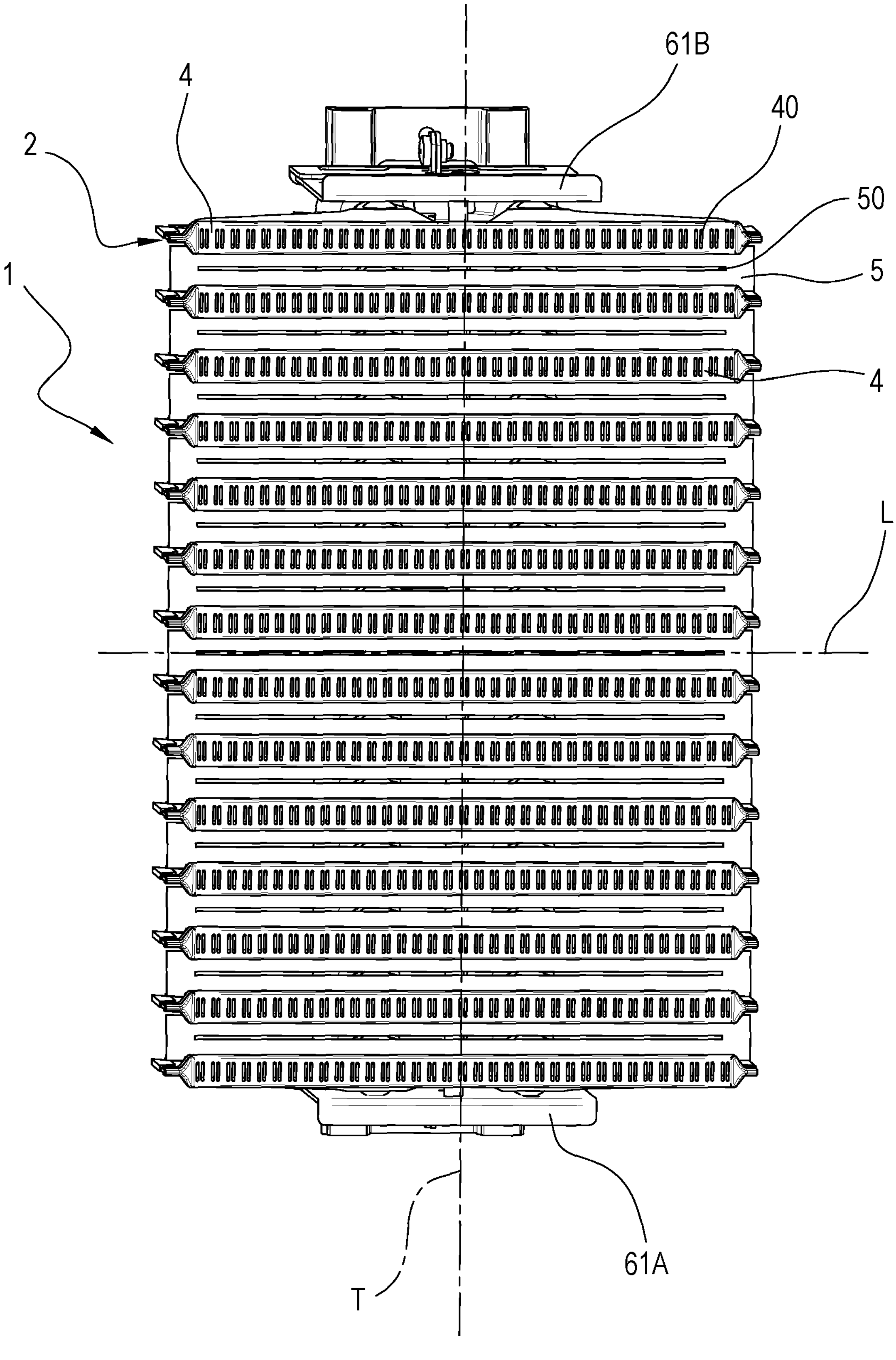


Fig. 2

Fig. 3



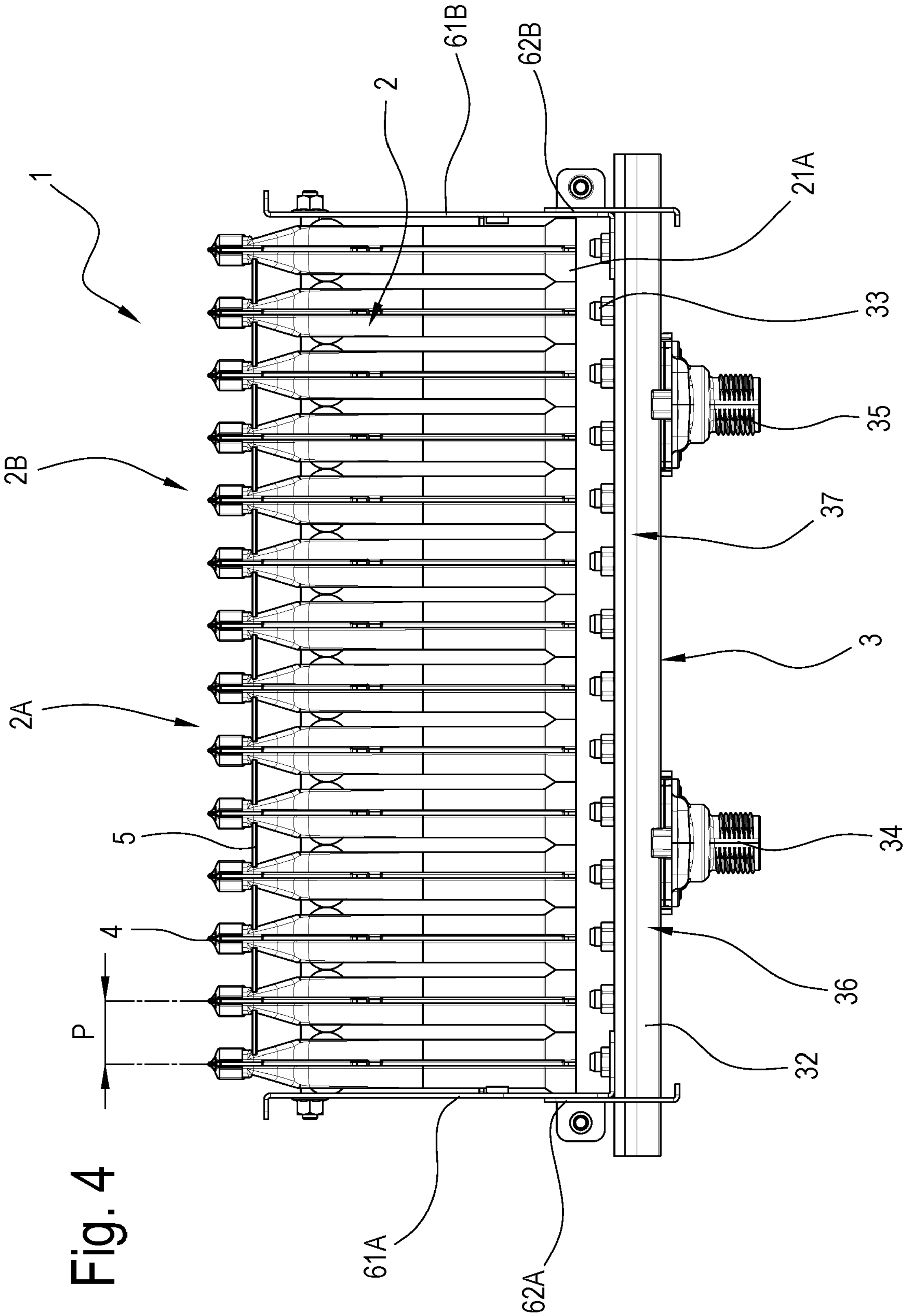


Fig. 4

Fig. 5

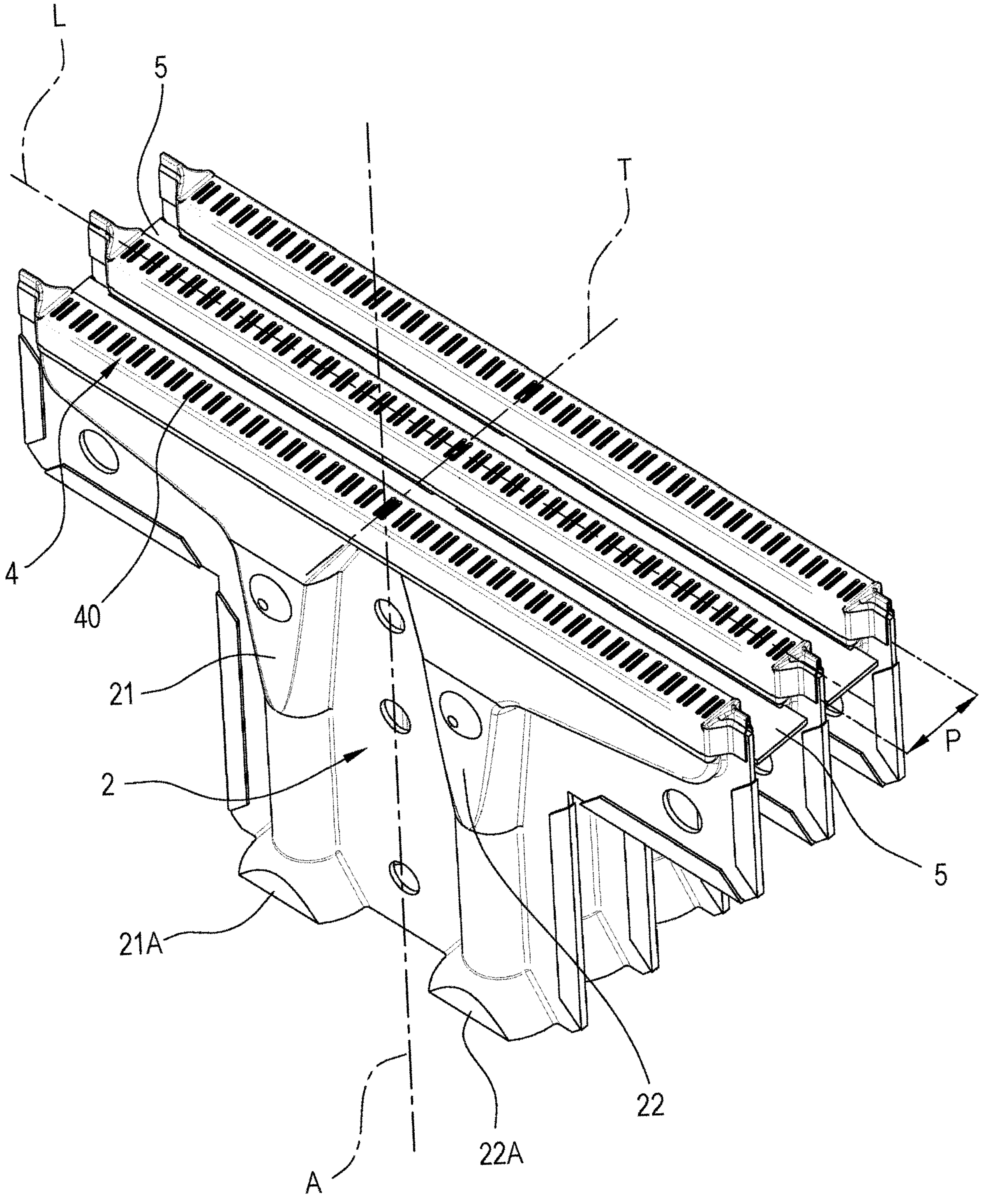


Fig. 6

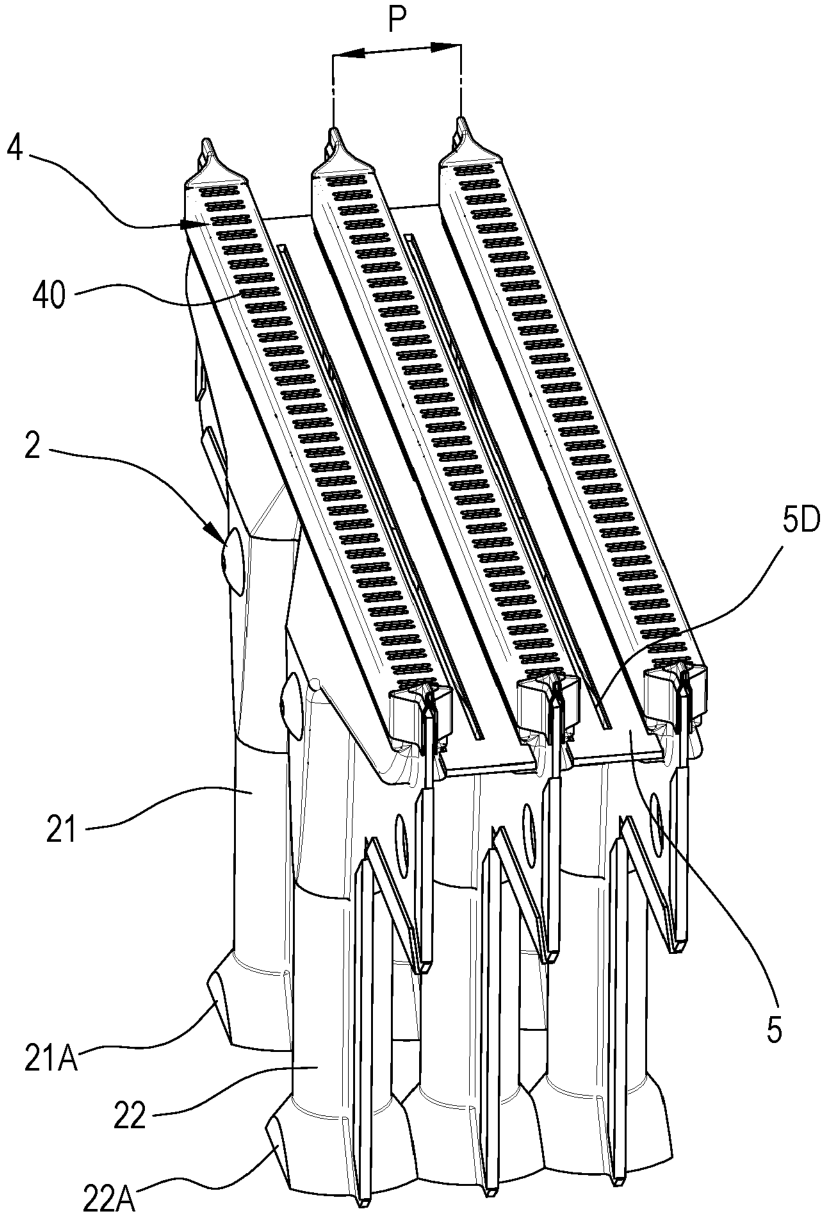


Fig. 7

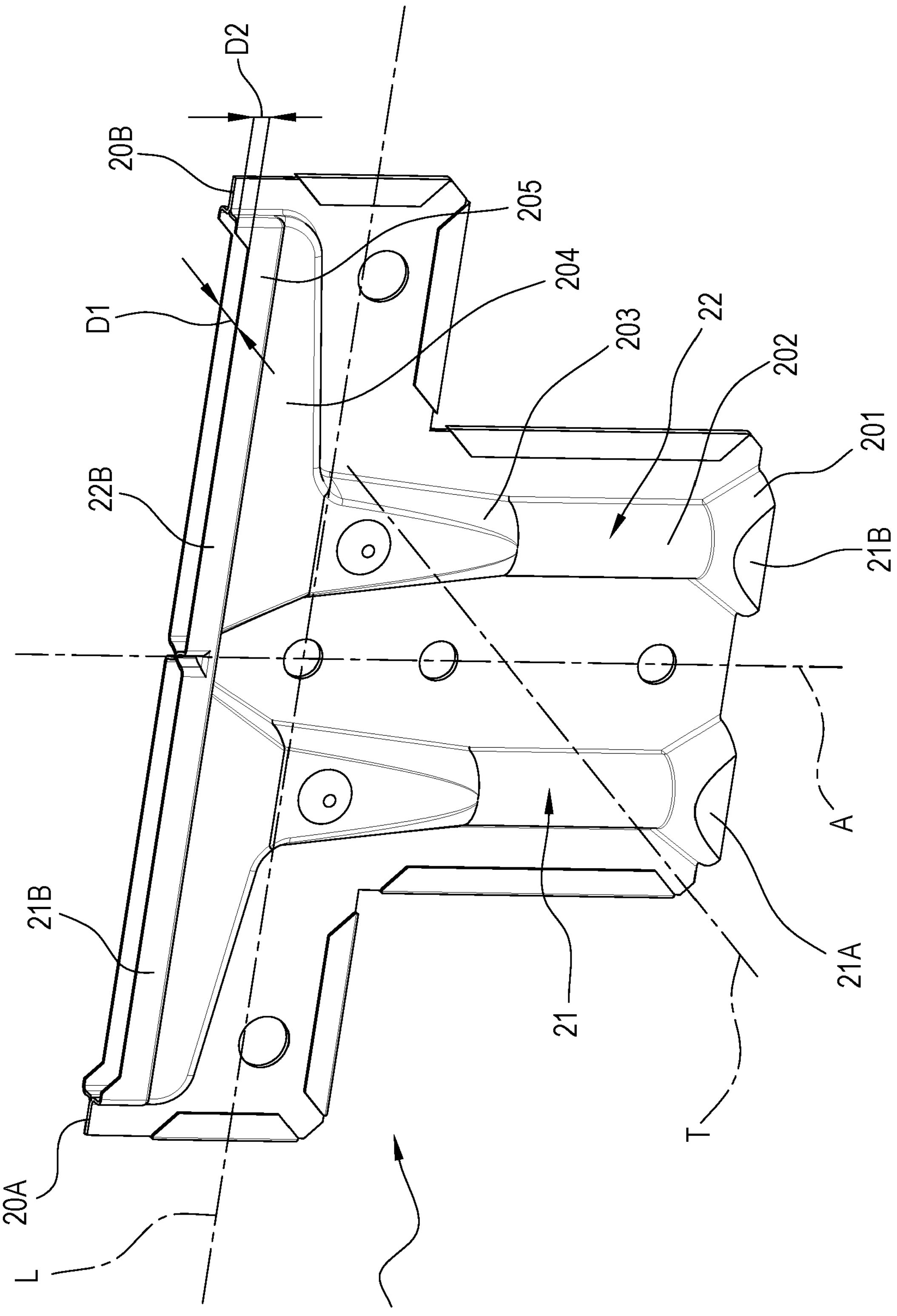


Fig. 8

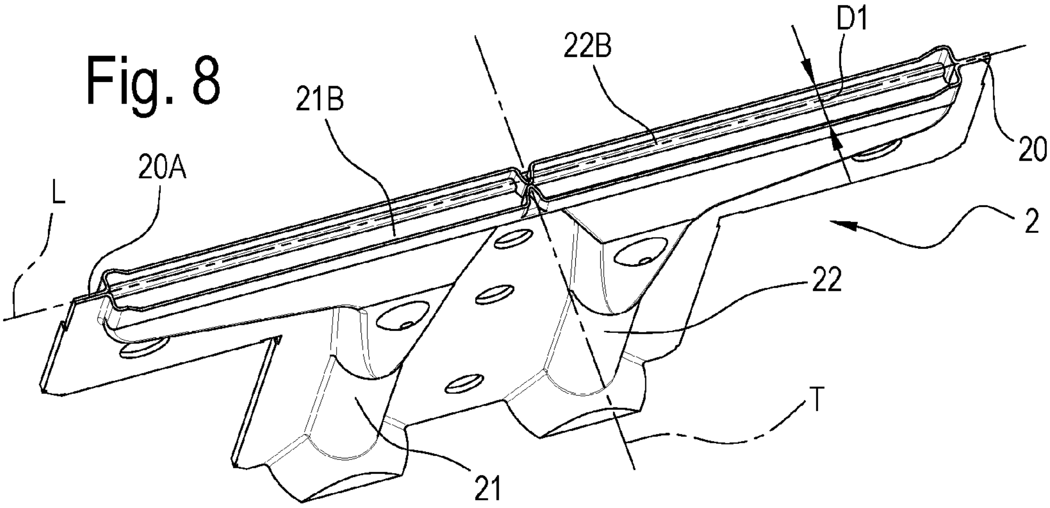


Fig. 9

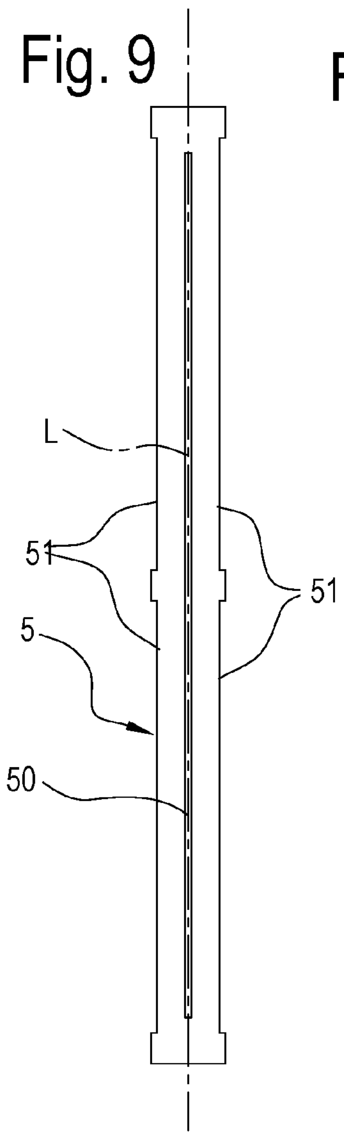


Fig. 10A

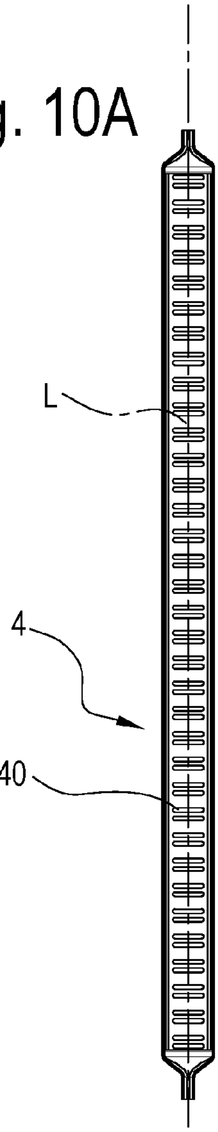
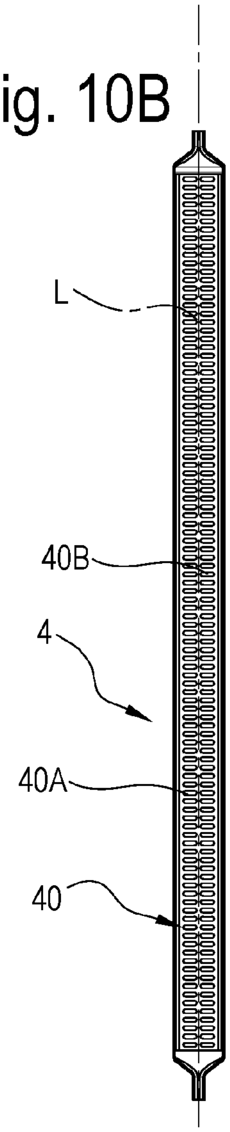


Fig. 10B



REFERENCES CITED IN THE DESCRIPTION

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