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(54) BURNER WITH DIFFUSING MEANS

BRENNER MIT DIFFUSIONSEINRICHTUNG

BRÛLEUR AVEC MOYEN DE DIFFUSION

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Description

Technical Field

[0001] The present invention relates to a burner usable in both the industrial and civil field.

Background Art

[0002] Burners are used e.g. in the ceramic industry, inside the equipment for the heat treatment of ceramic products, such as kilns and dryers.

[0003] The burners of known type are generally made of a supporting body, defining an air supply duct and a combustion gas supply duct, and of a combustion head through which the above-mentioned ducts are placed in communication with a combustion area. Such a burner is known from WO2011/120597. The combustion head in turn comprises an air diffuser, which has a plurality of openings communicating with the air supply duct to direct same towards the combustion area, and gas dispensing means, which have a plurality of flow gaps communicating with the gas supply duct to convey same towards the combustion area.

[0004] In the combustion area therefore the air is mixed with the combustion gas.

[0005] The diffuser of the combustion head generally consists of a plate-shaped element having a circular conformation, which is fitted around the gas supply duct and the entire thickness of which is crossed by the above openings.

[0006] The diffuser generally has a plurality of circular through holes, arranged along at least a circumference and having respective axes inclined so as to converge towards the extension of the longitudinal axis of the gas supply duct along the combustion area.

[0007] The diffuser also envisages a plurality of cuts obtained on its periphery according to planes inclined with respect to the longitudinal axis so as to give the air passing through it a helical movement.

[0008] These burners of known type do have a number of drawbacks.

[0009] They do not in fact allow obtaining a perfect mix of the air and combustion gas and cause, especially in the case of reduced gas flows, the formation of unburned materials with consequent inefficient combustion yield.

[0010] Nor do burners of known type ensure flame stability with gas flows close to the minimum or maximum values.

[0011] Furthermore, known burners are unable to adapt in a flexible way to the specific requirements of the case, meaning they do not permit an effective and prompt adjustment of flame intensity according to load conditions. This means that, e.g., in the event of the flame produced by the burner being unable to satisfy the necessary heat requirements, the burner has to be replaced with another of different size. In the same way, to heat environments of different conformation or size, burners

of different type must be used. All this inevitably translates into an increase in investment costs, and into more complex stock management and maintenance jobs.

[0012] Another drawback of burners of known type consists in the fact that the holes obtained in the proximity of the central seat of the diffuser tend to become dirty and blocked in time, requiring periodical maintenance and/or replacement jobs and undergoing a quick drop in performance between one job and another.

[0013] Yet another drawback of burners of known type consists in the fact that they do not allow making any adjustment of the flow rate of combustion fluid which is dispensed towards the combustion area. This limit is particularly evident in the limit operating conditions of the burners themselves, i.e., both during maximum peaks and during production gaps.

Description of the Invention

[0014] The main aim of the present invention is to provide a burner that allows achieving an effective mix of air and combustion gas, while at the same time ensuring high flame stability with both low and high gas flow rates.

[0015] As part of this aim, one object of the present invention is to provide a burner which permits easily regulating the geometry of the flame according to the specific requirements of the case in question.

[0016] Another object of the present invention is to allow the easy and quick adjustment of the output of the burner itself. More in particular, the present invention proposes to improve operation, with respect to burners of known type, both during maximum peaks and during production gaps.

[0017] Yet another object is to provide a burner which permits optimizing consumption with respect to burners of known type.

[0018] Another object of the present invention is to reduce, with respect to burners of known type, the maintenance jobs required to restore correct diffuser operation and therefore substantially maintain the performance of the burner itself unaltered over time.

[0019] Another object of the present invention is to provide a burner that allows to overcome the mentioned drawbacks of the background art in the ambit of a simple, rational, easy, effective to use and low cost solution.

[0020] The objects mentioned above are achieved by the present burner according to claim 1.

Brief Description of the Drawings

[0021] Other characteristics and advantages of the present invention will become more evident from the description of a preferred, but not sole, embodiment of a burner, illustrated purely as an example but not limited to the annexed drawings in which:

figure 1 is an axonometric view of a burner according to the invention;

figure 2 is an enlargement of the combustion head of the burner in figure 1;
 figure 3 is a simplified view of the combustion head shown in figure 2;
 figure 4 is a longitudinal section view of the burner in figure 1;
 figure 5 is an enlargement of a detail of the cross-section in figure 4;
 figure 6 is a front view of the internal diffusing element;
 figure 7 is a front view of the intermediate diffusing element;
 figure 8 is a front view of the external diffusing element;
 figure 9 is an axonometric view of the dispensing means of the combustion fluid in a first embodiment;
 figure 10 is a cross-section of the dispensing means in figure 9;
 figure 11 is an axonometric view of the dispensing means of the combustion fluid in a second embodiment;
 figure 12 is a cross-section of the dispensing means in figure 11;
 figure 13 is an axonometric view of the dispensing means of the combustion fluid in a third embodiment;
 figure 14 is a cross-section of the dispensing means in figure 13.

Embodiments of the Invention

[0022] With particular reference to such figures, globally indicated by 1 is a burner according to the invention, usable in both the industrial and civil field.

[0023] The burner 1 comprises a supporting body 2 which defines at least a first duct 3 for the supply of a combustive fluid and at least a second duct 4 for the supply of a combustion fluid.

[0024] More in particular, the supporting body 2 comprises a first tubular element 2a defining the first duct 3 and a second tubular element 2b defining the second duct 4. By the word "tubular" used here is meant any internally hollow element, irrespective of the shape of its cross-section, which can be any.

[0025] In the embodiment shown in the illustrations, the second tubular element 2b is arranged inside the first tubular element 2a. More in particular, the first duct 3 is therefore delimited at the side by the first and the second tubular elements 2a and 2b, while the second duct 4 is delimited at the side by the second tubular element 2b only. In the embodiment shown in the illustrations, the first duct 3 therefore extends around the second duct 4.

[0026] In the embodiment shown in the illustrations, the tubular elements 2a and 2b are substantially concentric with one another. The longitudinal axis of the first and of the second tubular elements 2a and 2b is identified in the illustrations by the reference letter A.

[0027] The first and the second ducts 2a and 2b have a first inlet mouth 5 for the combustive fluid and a second

inlet mouth 6 for the combustion fluid respectively.

[0028] The supporting body 2 also defines an inlet chamber 7 communicating with the first duct 3 through the first mouth 5 and having an inlet mouth 8 for the combustion fluid connectable to a ventilation system for blowing the combustive fluid, generally consisting of air.

[0029] The inlet chamber 7 is also arranged around the second tubular element 2b. Advantageously, the inlet chamber 7 has a plurality of conveying channels 40 for conveying the combustion fluid towards the first duct 3. More in detail, such conveying channels 40 are delimited by a plurality of ribs and are suitable for directing the combustion fluid in the inlet chamber 7 along a direction substantially parallel to the axis A of the first duct 3.

[0030] The first tubular element 2a and the portion of the supporting body 2 delimitating the inlet chamber 7 can be made in a single body piece or can be made separately, as in the embodiment shown in the illustrations.

[0031] The first tubular element 2a has a first extremity delimitating the first mouth 5 and a second extremity, opposite the first one, connected to diffusing means 9 of the combustive fluid.

[0032] In the embodiment shown in the illustrations, the first tubular element 2a also defines the outer overall dimensions of the supporting body 2, though alternative embodiments cannot be ruled out wherein the supporting body 2 also comprises a coating element of the first tubular element 2a open at one extremity and inside which the combustion head 15 is housed.

[0033] On the side surface of the first tubular element 2a are also defined a plurality of slots 10 distributed annularly to allow the flow of the combustive fluid from the first duct 3 towards the outside. This way, any excess combustive fluid can be released.

[0034] The second tubular element 2b also has a first extremity coupled to the second mouth 6 and a second extremity, opposite the first, connected to dispensing means 11 of the combustion fluid.

[0035] Suitably, the second tubular element 2b comprises a union element 12 defining an extremity section of the second duct 4. In particular, the second tubular element 2b comprises a main section 13 with which the union element 12 is associated integral. The main section 13 and the union element 12 can be made in a single body piece or separately as shown in the illustrations.

[0036] The combustion fluid is preferably in gaseous state such as natural gas.

[0037] To the supporting body 2 is associated a flange 14 suitable for allowing its fastening to a supporting structure.

[0038] The burner 1 then also comprises a combustion head 15 associated with the supporting body 2.

[0039] The combustion head 15 comprises the diffusing means 9 and the dispensing means 11.

[0040] The dispensing means 11 of the combustion fluid are communicating with the second duct 4 and have at least a gap 18 for the flow of the combustion fluid itself towards the combustion area 17. The dispensing means

11 are associated with the extremity section of the second duct 4 defined in the illustrations by the union element 12.

[0041] Preferably, the dispensing means 11 have a plurality of gaps 18 for the flow of the combustion fluid.

[0042] The diffusing means 9 are communicating with the first duct 3 and comprise a plurality of diffusing elements 9a,9b,9c having relative openings 16 mobile the one to the other to change the relative position of the openings defined on them. More in detail, at least one of the diffusing elements 9a,9b,9c can be moved with respect to the others to change the reciprocal position of the relative openings 16.

[0043] Each diffusing element 9a,9b,9c therefore has a plurality of openings 16 and by changing the reciprocal position of the diffusing elements 9a,9b,9c the combustive fluid flow section is therefore changed.

[0044] It therefore follows that, the combustive fluid flow rate being equal, by intervening on the reciprocal position of the diffusing elements 9a,9b,9c the geometry is consequently changed of the flame produced by the burner 1. More in particular, the greater the combustive fluid flow section defined by the openings 16 the lower the flow resistance, hence the greater extension of the flame produced.

[0045] In the same way, by changing the reciprocal position of the diffusing elements 9a,9b,9c so as to reduce the combustive fluid flow section, there is a consequent increase in flow resistance and a lesser extension of the flame produced.

[0046] In other words, the flow of combustive fluid receives minimum and maximum deviation in the condition wherein the openings 16 define, following the reciprocal movement of the diffusing elements 9a,9b,9c, the maximum and minimum flow section respectively. By changing the reciprocal position of the diffusing elements 9a,9b,9c, the deviation of the flow of the combustive fluid can therefore be regulated, to a lesser deviation corresponding a greater extension of the flame and vice versa.

[0047] Furthermore, the greater the combustion fluid flow section defined by the openings 16 the greater the conductible maximum flow rate, i.e., the output producible by the burner 1. In other words, by increasing the maximum air flow rate through the diffusing elements 9a,9b,9c the maximum flow is also increased of the gas that can be burned and, therefore, the output of the burner 1.

[0048] More in detail, the openings 16 are defined by a number of respective cuts 19 extending along a portion of the relative diffusing element 9a,9b,9c starting from its perimeter edge.

[0049] In a particular embodiment, the cuts 19 are defined according to a plane inclined with respect to the lying plane of the relative diffusing element 9a,9b,9c.

[0050] According to the invention, the openings 16 have a substantially curvilinear extension and have a growing section proceeding towards the peripheral edge of the relative diffusing element. The openings 16 thus conformed are suitable for directing the flow of combustive fluid passing through them with a helical pattern, op-

timizing the mix with the combustion fluid in the combustion area 17.

[0051] In the embodiment shown in the illustrations, the diffusing elements 9a,9b,9c have a substantially circular conformation and the openings 16 are arranged radially on them.

[0052] The diffusing elements 9a,9b,9c are of the plate-shaped type and are positioned substantially orthogonal to the longitudinal axis of the tubular elements 2a and 2b.

[0053] The diffusing elements 9a,9b,9c have a central through hole 20 by means of which they are fitted around the second tubular element 2b.

[0054] According to the invention, the diffusing elements 9a,9b,9c are fitted around the union element 12.

[0055] The diffusing elements 9a,9b,9c are superimposed on one another and are reciprocally mobile around a relative rotation axis. The rotation axis of the diffusing elements 9a,9b,9c substantially coincides with the longitudinal axis A of the tubular elements 2a and 2b.

[0056] Suitably, at least one of the diffusing elements 9a,9b,9c is fixed.

[0057] More in particular, at least the innermost diffusing element 9a, i.e., that closest to the first extremity of the first tubular element 2a, is fixed with respect to the supporting body 2. As shown in figure 7, the through hole 20 of the fixed diffusing element 9a is not circular but is shaped so as to cooperate with the union element 12 to prevent reciprocal rotation. The through hole 20 and the union element 12 have a complementary profile, i.e., they both define a pair of opposite rectilinear walls 20a cooperating with each other to stop the diffusing element 9a in rotation with respect to the second tubular element 2b.

[0058] In the preferred embodiment shown in the illustrations, the diffusing means 9 comprise three diffusing elements 9a,9b,9c superimposed on one another.

[0059] Of these three diffusing elements 9a,9b,9c two are fixed, and more in particular, the innermost diffusing element 9a and the intermediate one 9b, while the diffusing element 9c turned towards the combustion area 17 is mobile in rotation with respect to the other two. Both the through holes 20 of the fixed diffusing elements 9a and 9b have an identical profile, according to what has been described above, and are suitable for cooperating with the union element 12 around which they are fitted.

[0060] This configuration makes it easier to reciprocally regulate the diffusing elements, inasmuch as all the operator has to do is regulate the position of one of them; alternative embodiments cannot however be ruled out wherein two or more of the diffusing elements 9a,9b,9c are mobile.

[0061] Neither can alternative embodiments be ruled out comprising a greater or lesser number of diffusing elements with respect to the preferred embodiment shown in the illustrations.

[0062] According to the invention, the union element 12 has at least a section 12a which diverges proceeding towards the diffusing elements 9a,9b,9c, where the sec-

tion 12a protrudes inside the first duct 3 and is suitable for directing the combustive fluid flow towards the outer portions 16a of the openings 16, as indicated by the arrows shown in figure 8.

[0063] The combustive fluid is then deviated by the union element 12 towards the outer portion 16a of the openings 16. In other words, the union element 12, and in particular its section 12a, causes the combustive fluid to be deviated away from the portions of the openings 16 closest to the axis of the relative diffusing elements 9a, 9b, 9c. Such portions are henceforth defined "inner portions" and identified in the figures from 5 to 7 by the reference number 16b.

[0064] Most of the combustive fluid therefore crosses the outer portions 16a of the openings 16, while a minimum part passes through the inner portions 16b of the openings themselves. This results in a slight vacuum being created in the combustion area 17 in front of the inner portions 16b, downstream of the diffusing elements 9a, 9b, 9c. Such vacuum causes the combustive fluid passing through the outer portions 16a to be recalled towards the dispensing means 11, so as to permit the perfect mix of the combustion fluid with the combustive fluid itself.

[0065] Furthermore, the fact that the inner portions 16b are those with the smallest section also ensures that the quantity of combustive fluid itself which crosses them is minimum. This prevents, in particular in the case of the burner 1 being supplied with a low combustion fluid flow, the flow of combustive fluid passing through such inner portions not being strong enough to drag the combustion fluid outside the combustion area, thereby "tearing" the flame.

[0066] The wall of the second tubular element 2b delimiting laterally the second duct 4 defines at least a locator surface 21 against which rests one of the diffusing elements 9a, 9b, 9c, in particular the innermost diffusing element 9a.

[0067] More in detail, the locator surface 21 is defined by the union element 12 around which the diffusing elements 9a, 9b, 9c are fitted.

[0068] Suitably, means are provided for locking the reciprocal position of the diffusing elements 9a, 9b, 9c.

[0069] In the embodiments shown in the illustrations, the locking means correspond to the dispensing means 11, which define a locking surface 22 meant to rest against one of the diffusing elements 9a, 9b, 9c on the opposite side with respect to the locator surface 21.

[0070] The locking surface 22 is suitable for cooperating with the outermost diffusing element 9c.

[0071] The position of the dispensing means 11 with respect to the section of extremity of the second duct 4 with which they are associated, and defined in the illustrations by the union element 12, is adjustable so as to press the diffusing elements 9a, 9b, 9c placed between the surfaces 21 and 22 one against the other for the purpose of preventing their reciprocal movement during use.

[0072] More in particular, the dispensing means 11 are mobile between an adjustment position, wherein the lock-

ing surface 22 is moved away from the outermost diffusing element 9c to allow the reciprocal movement of the diffusing elements 9a, 9b, 9c, and a locking position, wherein the locking surface 22 cooperates with the outermost diffusing element 9c so as to pack up the diffusing elements themselves, thus making them reciprocally integral.

[0073] In the particular embodiment shown in the illustrations, the dispensing means 11 can be screwed onto the second tubular element 2b in correspondence to its second extremity defined by the union element 12.

[0074] In use, the dispensing means 11 are therefore unscrewed to allow the adjustment of the reciprocal position of the diffusing elements 9a, 9b, 9c, while these are screwed up to make them reciprocally integral during the operation of the burner 1.

[0075] Advantageously, the dispensing means 11 comprise at least a fixed portion 11a and a mobile portion 11b, where the position of the latter is adjustable with respect to the fixed portion 11a.

[0076] It is best to specify that, during the operation of the burner 1, the fixed portion 11a and the mobile portion 11b are integral with each other and stopped; in other words, in use, there is no relative movement between the portions 11a and 11b, the position of the mobile portion 11b being changeable during the periods when the burner 1 is not in use.

[0077] In particular, the fixed portion 11a is associated with the second extremity of the second tubular element 2b, defined in the particular embodiment shown in the illustrations by the union element 12. The fixed portion 11a is e.g. screwed onto the union element 12.

[0078] One between the fixed portion 11a and the mobile portion 11b defines the gaps 18 communicating with a dispensing channel 23 delimited by two opposite surfaces 24a and 24b defined by the fixed portion 11a and by the mobile portion 11b respectively.

[0079] Preferably, the opposite surfaces 24a and 24b, and therefore also the dispensing channel 23 defined by them, are arranged transversally to the longitudinal axis A.

[0080] As will be described in more detail below, the gaps 18 for the flow of the combustion fluid can be indifferently defined on the fixed portion 11a or on the mobile portion 11b.

[0081] By changing the position of the mobile portion 11b with respect to the fixed portion 11a the reciprocal distance is consequently changed of the opposite surfaces 24a and 24b and, consequently, of the flow section of the dispensing channel 23. It can be immediately appreciated how, by adjusting the position of the mobile portion 11b with respect to the fixed portion 11a it is possible to adjust the flow rate of the combustion fluid towards the combustion area 17.

[0082] It follows therefore that, by regulating the position of the mobile portion 11b with respect to the fixed portion 11a the output of the burner 1 can be adjusted.

[0083] In particular, the mobile portion 11b can be

moved between at least a lowered configuration wherein the opposite surfaces 24a and 24b are brought closer together, and a raised configuration wherein the opposite surfaces 24a and 24b are moved away from one another with respect to the lowered configuration. As it is easy to appreciate, the flow section, and therefore the flow rate of the combustion fluid, is at minimum in the lowered configuration and at maximum in the raised configuration.

[0084] Between the lowered configuration and the raised configuration, one or more intermediate configurations are provided. It is also easy for the technician in the sector to appreciate how the reciprocal distance of the opposite surfaces 24a and 24b in the extremal configurations can vary according to the chosen embodiment. For example, in the lowered configuration, the opposite surfaces 24a and 24b can be in contact with one another or, alternatively, at a minimum predefined distance.

[0085] Suitably, the burner 1 comprises means for regulating the position of the mobile portion 11b with respect to the fixed portion 11a. In particular, the adjustment of the position of the mobile portion 11b can be of the discrete or continuous type.

[0086] More in detail, the fixed portion 11a has a seat 25 inside which fits the mobile portion 11b. The mobile portion 11b is, e.g., screwed up inside the seat 25 defined on the fixed portion 11a.

[0087] In the embodiments shown in the figures from 9 to 12, the adjustment means comprise at least a locator element 28, having a predefined thickness, positioned between the fixed portion 11a and the mobile portion 11b. More in detail, the seat 25 defines an abutment surface 26 with which is suitable for cooperating a respective counter-abutment surface 27 defined on the mobile portion 11b and between which the locator element 28 is positioned. The locator element 28 is of the rigid type and its thickness defines the distance between the opposite surfaces 24a and 24b. More in detail, the mobile portion 11b is fitted inside the seat 25 until its counter-abutment surface 27 rests on the locator element 28 in turn arranged resting on the abutment surface 26. It is therefore easy to appreciate how, by varying the thickness of the locator element 28, the reciprocal position of the fixed portion 11a and of the mobile portion 11b is consequently changed.

[0088] In an alternative embodiment shown in the figures 13 and 14, the adjustment of the position of the mobile portion 11b is of the continuous type. In this embodiment, the mobile portion 11b is screwed up inside the seat 25 and safety means 29 are provided suitable for cooperating with the mobile portion itself to prevent its moving away from the fixed portion 11a. More in particular, the safety means 29 comprise, in the embodiment shown in the illustrations, a threaded element 29 which fits through a central through hole, threaded, defined on the fixed portion 11a. The bottom extremity of the threaded element 29 is therefore arranged inside the seat 25.

[0089] By adjusting the position of the threaded ele-

ment 29 with respect to the mobile portion 11b the maximum distance is consequently defined of the latter from the fixed portion 11a.

[0090] More in particular, by rotating the mobile portion 11b with respect to the fixed portion 11a, the former also moves with respect to the threaded element 29. It follows therefore that the mobile portion 11b can be screwed up/unscrewed with respect to the fixed portion 11a until the extremities of the thread of the threaded element 29 are reached.

[0091] It is therefore easy to appreciate how, to move the mobile portion 11b away from the fixed portion 11a, it is first of all necessary to adjust the threaded element 29, moving it with respect to the mobile portion itself, after which the latter is operated upon in such a way as to unscrew it until the limit position is reached defined by the thread of the threaded element 29. In the same way, to move the mobile portion 11b close to the fixed portion 11a, the mobile portion itself must be screwed up with respect to the fixed portion 11a, after which the threaded element 29 is screwed up on the mobile portion 11b in such a way as to lock the position of the latter (i.e., in such a way that the mobile portion 11b cannot be further unscrewed with respect to the threaded element 29).

[0092] As can be seen in detail in the attached illustrations, which show only some of the possible embodiments, the fixed portion 11a and the mobile portion 11b can take on various configurations, including ones considerably different from one another, but such as to allow in any case the adjustment of the flow rate of the combustion fluid towards the outside according to what has been described above.

[0093] In the embodiments shown in the figures 9, 10 and 13, 14, the fixed portion 11a comprises a plurality of combustion fluid flow channels 30 communicating with the second duct 4 and each defining a respective flow gap 18. The channels 30 extend along a direction substantially parallel to the second duct 4, while the gaps 18 are arranged (or have a lying plane) substantially orthogonal to such parallel direction.

[0094] In this embodiment, the gaps 18 face onto the surface 24a delimiting the dispensing channel 23.

[0095] In the alternative embodiment shown in the figures 11 and 12, the mobile portion 11b has a central channel 31 communicating, through the seat 25, with the second duct 4 and along the peripheral edge of which are defined the gaps 18. The central channel 31 is therefore substantially coaxial with the second duct 4 and the gaps 18 are arranged (or have a lying plane) substantially parallel to the longitudinal axis A. In this embodiment, the fixed portion 11a has a circular surface 32 which surrounds the section of the mobile portion 11b on which are defined the gaps 18 and which extends substantially parallel to the longitudinal axis A. More in particular, the circular surface 32 is substantially coaxial to the ducts 3 and 4.

[0096] Advantageously, the fixed portion 11a has, in correspondence to the circular surface 32, a plurality of

recesses 33, e.g., shaped in a semi-circle, angularly distanced from one another and arranged substantially parallel to the gaps 18. These recesses 33 define the minimum flow rate of the combustion fluid in the configuration corresponding to the smaller flow section of the dispensing channel 23, i.e., wherein the surfaces 24a and 24b are in contact with one another.

[0097] Preferably, the section of the mobile portion 11b decreases proceeding from the second duct 4 towards the dispensing area 17, as shown in the embodiments in the figures from 9 to 12.

[0098] This particular conformation of the mobile portion 11b, the section of which narrows therefore towards the longitudinal axis A proceeding towards the outside, permits the formation of a local vacuum that causes a suction effect on the combustible fluid and on the combustion fluid thus giving rise to an effective mix of same.

[0099] More in detail, the combustion fluid exiting with whirling movement from the diffusing elements 9a, 9b and 9c and the combustion fluid which exits through the dispensing channel 23 transversally to the longitudinal axis A, are sucked up towards the combustion area 17 by effect of the variation in section of the mobile portion 11b.

[0100] The burner 1 also has an ignition electrode 34 and a control sensor 35 of the combustion, both of traditional type and, therefore, not described in detail.

[0101] The ignition electrode 34 and the control sensor 35 are arranged aligned with the longitudinal axis A and are fitted passing through the diffusing elements 9a, 9b, 9c within respective seats 36, terminating in correspondence to the combustion area 17.

[0102] The operation of the present invention is the following.

[0103] Before igniting the burner 1, depending on the specific requirements of the case, the operator consequently regulates the reciprocal position of the diffusing elements 9a, 9b and 9c and of the mobile portion 11b with respect to the fixed portion 11a.

[0104] The operator then makes the above adjustments according to a series of parameters, including the Kcal/h the burner 1 has to dispense, the dimensions of the premises to be heated, the ideal stoichiometric ratio between air and gas.

[0105] In particular, the operator unscrews the fixed portion 11a from the union element 12 so as to loosen the compression force acting on the diffusing elements 9a, 9b and 9c and thus allow the adjustment of the angular position of the outermost diffusing element 9c with respect to the fixed diffusing elements 9a and 9b.

[0106] This way, as described above in detail, we intervene on the air flow section and, therefore, on the geometry of the flame produced by the burner 1.

[0107] Once the desired position of the outermost diffusing element 9c has been identified, the operator again screws up the fixed portion 11a on the union element 12 again packing up the diffusing elements 9a, 9b and 9c so as to make them reciprocally integral.

[0108] The operator then proceeds in the same way with regard to the dispensing means 11 as well, i.e., he/she changes the flow section of the dispensing channel 23 intervening on the reciprocal position of the fixed portion 11a and on that of the mobile section 11b.

[0109] As described above, the adjustment mode of the position of the mobile portion 11b with respect to the fixed portion 11a can be of the discrete or the continuous type.

[0110] In the first case, of which the embodiments shown in the figures from 9 to 12 are an example, the operator removes the mobile portion 11b from the fixed portion 11a and replaces the intermediate element 28 and fits one of different thickness.

[0111] In the second case instead, shown in the figures 13 and 14, the operator intervenes on the threaded element 29 and on the mobile portion 11b to change the position of the latter according to what has been described above.

[0112] It has in fact been ascertained how the described invention achieves the proposed objects and in particular the fact is underlined that the burner forming the subject of the present invention permits adjusting, in an easy and practical way, the geometry, and therefore the extension, of the flame of the burner itself. In particular, the synergic effect due to the diverging conformation of the union element over which are fitted the diffusing elements and the diverging conformation of the openings obtained on the diffusing elements themselves allow at the same time obtaining a perfect combustion fluid-combustive fluid mix besides keeping the flame at any operating level of the burner itself, i.e., with both high and low gas flow rates.

[0113] This adjustment, made solely by intervening on the reciprocal position of the diffusing elements fitted to the combustion head, permits adapting, in an extremely flexible way, the operation of the burner itself to the specific requirements of the case. More in particular, the burner forming the subject of the present invention is also usable for different conformations and dimensions of the environment to be heated. This is extremely advantageous for example in the ceramic industry, where the same burner can adapt to different widths and manage to also effectively heat the tiles in the central part of the kiln itself, thus avoiding the formation of unburned material.

[0114] The burner according to the invention thus makes it possible to optimize the heating phases which distinguish the ceramic process, thereby permitting the reduction of the firing cycles and, consequently, an increase in production per unit of time.

[0115] Furthermore, it must be pointed out how the particular conformation of the dispensing means of the combustion fluid also allows changing, in an easy and precise way, the flow rate of same towards the combustion area. This permits regulating the burner output according to need, reducing the formation of carbon residues in the combustion area and easily adapting the operation of the

burner to both maximum peaks and production gaps (in case of use in the industrial field, e.g., in the ceramic industry).

Claims

1. Burner (1) comprising:

a supporting body (2) which comprises a first tubular element (2a) and a second tubular element (2b) arranged inside the first tubular element itself, where the volume positioned between said first and said second tubular elements (2a, 2b) defines at least a first duct (3) for the flow of a combustive fluid and where said second tubular element (2b) defines at least a second duct (4) for the flow of a combustion fluid; said second tubular element (2b) comprising a union element (12) defining an extremity section of said second duct (4);

a combustion head (15) associated with said supporting body (2) and comprising diffusing means (9), communicating with said first duct (3) and having a plurality of openings (16) for the flow of the combustive fluid towards a combustion area (17), where said diffusing means (9) comprise at least two diffusing elements (9a, 9b, 9c) having relative openings (16) for the flow of the combustive fluid and mobile reciprocally the one to the other to change the relative position of said openings (16), and dispensing means (11) of the combustion fluid, communicating with said second duct (4) and having a plurality of gaps (18) for the flow of the combustion fluid itself towards said combustion area (17);

wherein said diffusing elements (9a, 9b, 9c) are fitted around said union element (12), wherein each of them has a plurality of said openings (16) defined by respective through cuts (19) extending along a portion of the relative diffusing element (9a, 9b, 9c), where said openings (16) have a substantially curvilinear extension and have a growing section proceeding outwards, and wherein said union element (12) has at least a section (12a) which diverges proceeding towards said diffusing elements (9a, 9b, 9c), where said diverging section (12a) protrudes inside said first duct (3) and is suitable for directing the combustive fluid flow towards the outer portions (16a) of said openings (16).

2. Burner (1) according to claim 1, **characterized by** the fact said diffusing elements (9a, 9b, 9c) are superimposed on one another and are reciprocally mobile in rotation to change the flow section of the combustive fluid.

3. Burner (1) according to one or more of the preceding claims, **characterized by** the fact that at least one of said diffusing elements (9a, 9b) is fixed.

4. Burner (1) according to claim 3, **characterized by** the fact said fixed diffusing element (9a) is at least the innermost one to said first duct (3).

5. Burner (1) according to one or more of the preceding claims, **characterized by** the fact that it comprises at least three of said diffusing elements (9a, 9b, 9c).

6. Burner (1) according to claim 5, **characterized by** the fact that two of said diffusing elements (9a, 9b) are fixed, the one turned towards the outside (9c) of said first duct (3) being mobile with respect to them.

7. Burner (1) according to one or more of the preceding claims, **characterized by** the fact that the wall of said supporting body (2) delimiting said second duct (4) defines a locator surface (21) against which rests one of said diffusing elements (9a).

8. Burner (1) according to claim 7, **characterized by** the fact said locator surface (21) is defined by said union element (12).

9. Burner (1) according to one or more of the preceding claims, **characterized by** the fact that it comprises locking means for locking the reciprocal position of said diffusing elements (9a, 9b, 9c).

10. Burner (1) according to claim 9, **characterized by** the fact that said locking means correspond to said dispensing means (11), which have a locking surface (22) meant to rest against one of said diffusing elements (9c) opposite said locator surface (21), the position of said dispensing means (11) with respect to said locator surface (21) being adjustable between at least an adjustment position, wherein they allow the reciprocal movement of said diffusing elements (9a, 9b, 9c), and a locking position, wherein they prevent the reciprocal movement of said diffusing elements (9a, 9b, 9c).

11. Burner (1) according to one or more of the preceding claims, **characterized by** the fact that said dispensing means (11) comprise at least a fixed portion (11a) and a mobile portion (11b), where one between said fixed portion (11a) and said mobile portion (11b) defines said flow gaps (18) communicating with at least a dispensing channel (23) delimited by at least two opposite surfaces (24a, 24b) defined by said fixed portion (11a) and by said mobile portion (11b) respectively, the position of said mobile portion (11b) with respect to said fixed portion (11a) being adjustable to change the flow section of said dispensing channel (23).

12. Burner (1) according to claim 11, **characterized by** the fact that the position of said mobile portion (11b) with respect to said fixed portion (11a) is adjustable between a lowered configuration, wherein said opposite surfaces (24a, 24b) are brought closer together, and a raised configuration, wherein said opposite surfaces (24a, 24b) are moved away from one another with respect to said lowered configuration, the flow section of said dispensing channel (23) being at minimum in said lowered configuration and at maximum in said raised configuration. 5 10
13. Burner (1) according to claim 11 **characterized by** the fact that said dispensing channel (23) extends transversally with respect to the longitudinal extension of said second duct (4). 15
14. Burner (1) according to claim 11, **characterized by** the fact that said burner comprises means for regulating the position of said mobile portion (11b) with respect to said fixed portion (11a). 20
15. Burner (1) according to claim 11, **characterized by** the fact that said mobile portion (11b) has a section which decreases proceeding towards said combustion area (17). 25
16. Burner (1) according to one or more of the preceding claims, **characterized by** the fact that said openings (16) are defined by a number of respective cuts (19) extending along a portion of the relative diffusing element (9a, 9b, 9c) starting from its perimeter edge. 30
17. Burner (1) according to claim 3, **characterized by** the fact that the through hole (20) of the fixed diffusing element (9a) is not circular but is shaped so as to cooperate with the union element (12) to prevent reciprocal rotation. 35
18. Burner (1) according to claim 17, **characterized by** the fact that the through hole (20) and the union element (12) have a complementary profile, preferably they both define a pair of opposite rectilinear walls (20a) cooperating with each other to stop the fixed diffusing element (9a) in rotation with respect to the second tubular element (2b). 40 45

Patentansprüche

1. Brenner (1) umfassend:

einen Stützkörper (2), der ein erstes rohrförmiges Element (2a) umfasst und ein zweites rohrförmiges Element (2b), das in dem besagten ersten rohrförmigen Element selbst angeordnet ist, wobei das zwischen dem besagten ersten und dem besagten zweiten rohrförmigen Ele-

ment (2a, 2b) positionierte Volumen mindestens einen ersten Kanal (3) für das Strömen eines brennbaren Fluids definiert und wobei das besagte zweite rohrförmige Element (2b) mindestens einen zweiten Kanal (4) für das Strömen eines Verbrennungsfluids definiert; das besagte zweite rohrförmige Element (2b) umfassend ein Verbindungselement (12), das einen Endbereich des besagten Kanals (4) definiert; einen Brennkopf (15), der dem besagten Stützkörper (2) zugeordnet ist und umfassend Diffusionsmittel (9), die mit dem besagten ersten Kanal (3) in Verbindung stehen und eine Vielzahl von Öffnungen (16) für das Strömen eines brennbaren Fluids zum Verbrennungsbereich (17) aufweisen, wobei die besagten Diffusionsmittel (9) mindestens zwei Diffusionselemente (9a, 9b, 9c) umfassen mit entsprechenden Öffnungen (16) für das Strömen des brennbaren Fluids und eines am anderen gegeneinander beweglich, um die entsprechende Position der besagten Öffnungen (16) zu ändern, und Abgabemittel (11) des Verbrennungsfluids, die mit dem besagten zweiten Kanal (4) in Verbindung stehen und eine Vielzahl von Spalten (18) für das Strömen des Verbrennungsfluids selbst zum besagten Verbrennungsbereich (17) aufweisen; worin die besagten Diffusionselemente (9a, 9b, 9c) um das besagte Verbindungselement (12) herum angebracht sind, worin jedes von ihnen eine Vielzahl von Öffnungen (16) aufweist, die durch jeweilige Durchgangsschnitte (19) definiert sind, die sich entlang eines Abschnitts des entsprechenden Diffusionselements (9a, 9b, 9c) erstrecken, wobei die besagten Öffnungen (16) eine im Wesentlichen gekrümmte Erstreckung aufweisen und einen nach außen hin zunehmenden Querschnitt, und worin das besagte Verbindungselement (12) mindestens einen Abschnitt (12a) aufweist, der zu den besagten Diffusionselementen (9a, 9b, 9c) hin auseinanderläuft, wobei dieser auseinanderlaufende Abschnitt (12a) in den besagten ersten Kanal (3) hineinragt und zum Lenken des Stroms des brennbaren Fluids zu den äußeren Abschnitten (16a) der besagten Öffnungen (16) geeignet ist.

2. Brenner (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die besagten Diffusionselemente (9a, 9b, 9c) übereinander angeordnet sind und gegeneinander drehbeweglich sind, um den Strömungsabschnitt des brennbaren Fluids zu ändern.
3. Brenner (1) nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet,**

dass mindestens eines der besagten Diffusionselemente (9a, 9b) befestigt ist.

4. Brenner (1) nach Anspruch 3, **dadurch gekennzeichnet, dass** das besagte befestigte Diffusionselement (9a) das mindestens am weitesten innenliegende an dem besagten ersten Kanal (3) ist. 5
5. Brenner (1) nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** er mindestens drei der besagten Diffusionselemente (9a, 9b, 9c) umfasst. 10
6. Brenner (1) nach Anspruch 5, **dadurch gekennzeichnet, dass** zwei der besagten Diffusionselemente (9a, 9b) befestigt sind, wobei das nach außen gerichtete (9c) des besagten ersten Kanals (3) in Bezug auf sie beweglich ist. 15
7. Brenner (1) nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Wand des besagten Stützkörpers (2), die den besagten zweiten Kanal (4) begrenzt, eine Auflagefläche (21) definiert, gegen die sich eines der besagten Diffusionselemente (9a) stützt. 20 25
8. Brenner (1) nach Anspruch 7, **dadurch gekennzeichnet, dass** die besagte Lagerfläche (21) durch das besagte Verbindungselement (12) definiert ist. 30
9. Brenner (1) nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** er Verriegelungsmittel zum Verriegeln der gegenseitigen Position der besagten Diffusionselemente (9a, 9b, 9c) umfasst. 35
10. Brenner (1) nach Anspruch 9, **dadurch gekennzeichnet, dass** die besagten Verriegelungsmittel den besagten Abgabemitteln (11) entsprechen, die eine Verriegelungsfläche (22) aufweisen, die zur Anlage an einem der besagten Diffusionselemente (9c) gegenüber der besagten Lagerfläche (21) bestimmt sind, wobei die Position der besagten Abgabemittel (11) in Bezug auf die besagte Lagerfläche (21) zwischen mindestens einer Einstellposition einstellbar ist, worin sie eine Hin- und Herbewegung der besagten Diffusionselemente (9a, 9b, 9c) erlauben, und einer Verriegelungsposition, worin sie die Hin- und Herbewegung der besagten Diffusionselemente (9a, 9b, 9c) verhindern. 40 45 50
11. Brenner (1) nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die besagten Abgabemittel (11) mindestens einen festen Abschnitt (11a) und einen beweglichen Abschnitt (11b) umfassen, wobei einer zwischen dem besagten festen Abschnitt (11a) und dem besagten beweglichen Abschnitt (11b) die besagten 55

Strömungsspalten (18) definiert, die mit dem mindestens einen Abgabekanal (23) in Verbindung stehen, der durch mindestens zwei gegenüberliegende Flächen (24a, 24b) begrenzt wird, die jeweils durch den besagten festen Abschnitt (11a) und durch den besagten beweglichen Abschnitt (11b) definiert werden, wobei die Position des besagten beweglichen Abschnitts (11b) in Bezug auf den festen Abschnitt (11a) einstellbar ist, um den Strömungsabschnitt des besagten Abgabekanals (23) zu ändern.

12. Brenner (1) nach Anspruch 11, **dadurch gekennzeichnet, dass** die Position des besagten beweglichen Abschnitts (11b) in Bezug auf den festen Abschnitt (11a) einstellbar ist zwischen einer abgesenkten Konfiguration, worin die besagten gegenüberliegenden Flächen (24a, 24b) näher zusammengebracht werden, und einer angehobenen Konfiguration, worin die besagten gegenüberliegenden Flächen (24a, 24b) in Bezug auf die besagte abgesenkte Konfiguration voneinander wegbewegt werden, wobei der Strömungsabschnitt des besagten Abgabekanals (23) in der besagten abgesenkten Konfiguration minimal und in der besagten angehobenen Konfiguration maximal ist.
13. Brenner (1) nach Anspruch 11, **dadurch gekennzeichnet, dass** sich der besagte Abgabekanal (23) in Bezug auf die Längserstreckung des besagten zweiten Kanals (4) quer erstreckt.
14. Brenner (1) nach Anspruch 11, **dadurch gekennzeichnet, dass** der besagte Brenner Mittel zur Positionsregelung des besagten beweglichen Abschnitts (11b) in Bezug auf den besagten festen Abschnitt (11a) umfasst.
15. Brenner (1) nach Anspruch 11, **dadurch gekennzeichnet, dass** der besagte bewegliche Abschnitt (11b) einen Abschnitt aufweist, der zu dem besagten Verbrennungsbereich (17) hin abnimmt.
16. Brenner (1) nach einem oder mehreren der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die besagten Öffnungen (16) durch eine Anzahl von jeweiligen Schnitten (19) definiert sind, die sich entlang eines Abschnitts des entsprechenden Diffusionselements (9a, 9b, 9c), beginnend bei seiner Umfangskante, erstrecken.
17. Brenner (1) nach Anspruch 3, **dadurch gekennzeichnet, dass** das Durchgangsloch (20) des befestigten Diffusionselements (9a) nicht kreisförmig ist, sondern zum Zusammenwirken mit dem Verbindungselement (12) geformt ist, um eine gegenseitige Drehung zu verhindern.

18. Brenner (1) nach Anspruch 17, **dadurch gekennzeichnet, dass** das besagte Durchgangsloch (20) und das Verbindungselement (12) ein komplementäres Profil aufweisen, vorzugsweise definieren beide ein Paar einander gegenüberliegender geradliniger Wände (20a), die miteinander zusammenwirken, um das befestigte Diffusionselement (9a) in Drehung in Bezug auf das zweite rohrförmige Element (2b) zu stoppen.

Revendications

1. Brûleur (1) comprenant :

un corps de support (2) comprenant un premier élément tubulaire (2a) et un deuxième élément tubulaire (2b) disposé à l'intérieur du premier élément tubulaire même, où le volume positionné entre ledit premier et ledit deuxième éléments tubulaires (2a, 2b) définit au moins un premier conduit (3) pour l'écoulement d'un fluide combustible et où ledit deuxième élément tubulaire (2b) définit au moins un deuxième conduit (4) pour l'écoulement d'un fluide de combustion; ledit deuxième élément tubulaire (2b) comprenant un élément de raccord (12) définissant une section d'extrémité dudit deuxième conduit (4); une tête de combustion (15) associée audit corps de support (2) et comprenant des moyens de diffusion (9), en communication avec ledit premier conduit (3) et ayant une pluralité d'ouvertures (16) pour l'écoulement du fluide combustible vers une zone de combustion (17), où lesdits moyens de diffusion (9) comprennent au moins deux éléments diffuseurs (9a, 9b, 9c) ayant des ouvertures (16) relatives pour l'écoulement du fluide combustible et mobiles réciproquement l'un par rapport à l'autre pour modifier la position relative desdites ouvertures (16), et des moyens de distribution (11) du fluide de combustion, en communication avec ledit deuxième conduit (4) et ayant une pluralité d'espaces (18) pour l'écoulement dudit fluide de combustion vers ladite zone de combustion (17); dans lequel lesdits éléments diffuseurs (9a, 9b, 9c) sont disposés autour dudit élément de raccord (12), dans lequel chacun d'eux comporte une pluralité desdites ouvertures (16) définies par des découpes (19) respectives s'étendant le long d'une partie de l'élément diffuseur (9a, 9b, 9c) relatif, où lesdites ouvertures (16) ont une extension sensiblement curviligne et comportent une section croissante vers l'extérieur, et dans lequel ledit élément de raccord (12) a au moins une section (12a) qui diverge vers lesdits éléments diffuseurs (9a, 9b, 9c), où ladite

section divergente (12a) est saillante à l'intérieur dudit premier conduit (3) et est adaptée pour diriger l'écoulement de fluide combustible vers les parties extérieures (16a) desdites ouvertures (16).

2. Brûleur (1) selon la revendication 1, **caractérisé en ce que** lesdits éléments diffuseurs (9a, 9b, 9c) sont superposés l'un sur l'autre et sont mobiles réciproquement en rotation pour modifier la section d'écoulement du fluide combustible.
3. Brûleur (1) selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**au moins l'un desdits éléments diffuseurs (9a, 9b) est fixe.
4. Brûleur (1) selon la revendication 3, **caractérisé en ce que** ledit élément diffuseur fixe (9a) est au moins le plus à l'intérieur par rapport audit premier conduit (3).
5. Brûleur (1) selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**il comprend au moins trois desdits éléments diffuseurs (9a, 9b, 9c).
6. Brûleur (1) selon la revendication 5, **caractérisé en ce que** deux desdits éléments diffuseurs (9a, 9b) sont fixes, celui tourné vers l'extérieur (9c) dudit premier conduit (3) étant mobile par rapport à eux.
7. Brûleur (1) selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** la paroi dudit corps de support (2) délimitant ledit deuxième conduit (4) définit une surface de repère (21) contre laquelle un desdits éléments diffuseurs (9a) repose.
8. Brûleur (1) selon la revendication 7, **caractérisé en ce que** ladite surface de repère (21) est définie par ledit élément de raccord (12).
9. Brûleur (1) selon une ou plusieurs des revendications précédentes, **caractérisé en ce qu'**il comprend des moyens de blocage pour bloquer la position réciproque desdits éléments diffuseurs (9a, 9b, 9c).
10. Brûleur (1) selon la revendication 9, **caractérisé en ce que** lesdits moyens de blocage correspondent auxdits moyens de distribution (11), qui ont une surface de blocage (22) destinée à reposer contre l'un desdits éléments diffuseurs (9c) opposé à ladite surface de repère (21), la position desdits moyens de distribution (11) par rapport à ladite surface de repère (21) étant ajustable entre au moins une position d'ajustement, dans laquelle ils permettent le mouvement réciproque desdits éléments diffuseurs (9a, 9b, 9c), et une position de blocage, dans laquelle ils em-

pêchent le mouvement réciproque desdits éléments diffuseurs (9a, 9b, 9c).

11. Brûleur (1) selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdits moyens de distribution (11) comprennent au moins une partie fixe (11a) et une partie mobile (11b), l'une parmi ladite partie fixe (11a) et ladite partie mobile (11b) définissant lesdits espaces d'écoulement (18) en communication avec au moins un canal de distribution (23) délimité par au moins deux surfaces opposées (24a, 24b) définies par ladite partie fixe (11a) et par ladite partie mobile (11b) respectivement, la position de ladite partie mobile (11b) par rapport à ladite partie fixe (11a) étant ajustable pour modifier la section d'écoulement dudit canal de distribution (23) . 5 10 15
12. Brûleur (1) selon la revendication 11, **caractérisé en ce que** la position de ladite partie mobile (11b) par rapport à ladite partie fixe (11a) est ajustable entre une configuration abaissée, dans laquelle lesdites surfaces opposées (24a, 24b) sont rapprochées ensemble, et une configuration relevée, dans laquelle lesdites surfaces opposées (24a, 24b) sont éloignées l'une de l'autre par rapport à ladite configuration abaissée, la section d'écoulement dudit canal de distribution (23) étant au minimum dans ladite configuration abaissée et au maximum dans ladite configuration relevée. 20 25 30
13. Brûleur (1) selon la revendication 11, **caractérisé en ce que** ledit canal de distribution (23) s'étend transversalement par rapport à l'extension longitudinale dudit deuxième conduit (4). 35
14. Brûleur (1) selon la revendication 11, **caractérisé en ce que** ledit brûleur comprend des moyens pour régler la position de ladite partie mobile (11b) par rapport à ladite partie fixe (11a). 40
15. Brûleur (1) selon la revendication 11, **caractérisé en ce que** ladite partie mobile (11b) a une section qui diminue vers ladite zone de combustion (17). 45
16. Brûleur (1) selon une ou plusieurs des revendications précédentes, **caractérisé en ce que** lesdites ouvertures (16) sont définies par plusieurs découpes (19) respectives s'étendant le long d'une partie de l'élément diffuseur (9a,9b,9c) relatif à partir de son bord périphérique. 50
17. Brûleur (1) selon la revendication 3, **caractérisé en ce que** le trou traversant (20) de l'élément diffuseur (9a) fixe n'est pas circulaire mais est formé de façon à coopérer avec l'élément de raccord (12) pour empêcher une rotation réciproque. 55

18. Brûleur (1) selon la revendication 17, **caractérisé en ce que** le trou traversant (20) et l'élément de raccord (12) ont un profil complémentaire, préférablement ils tous deux définissent une paire de parois opposées rectilignes (20a) coopérant l'une avec l'autre pour arrêter l'élément diffuseur (9a) fixe en rotation par rapport au deuxième élément tubulaire (2b) .

Fig. 1

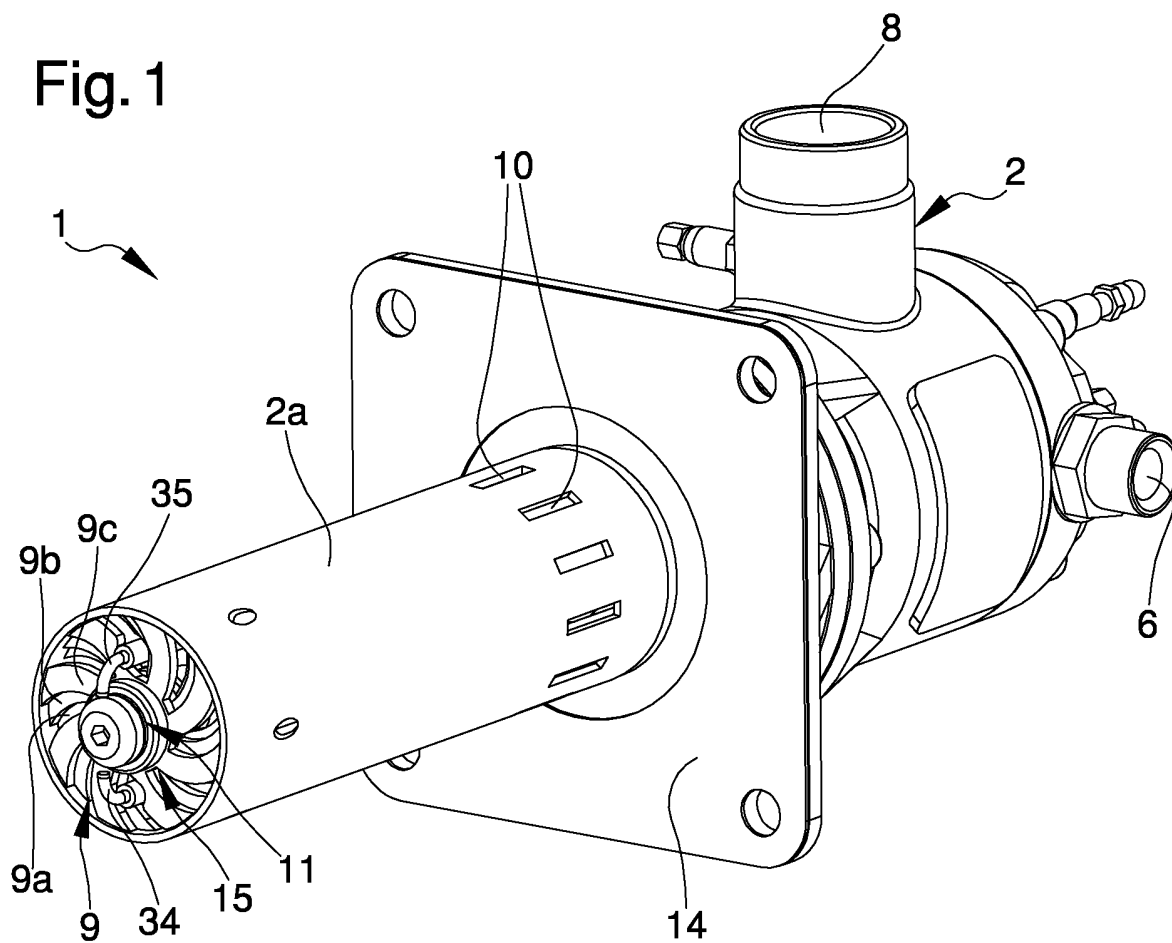


Fig. 2

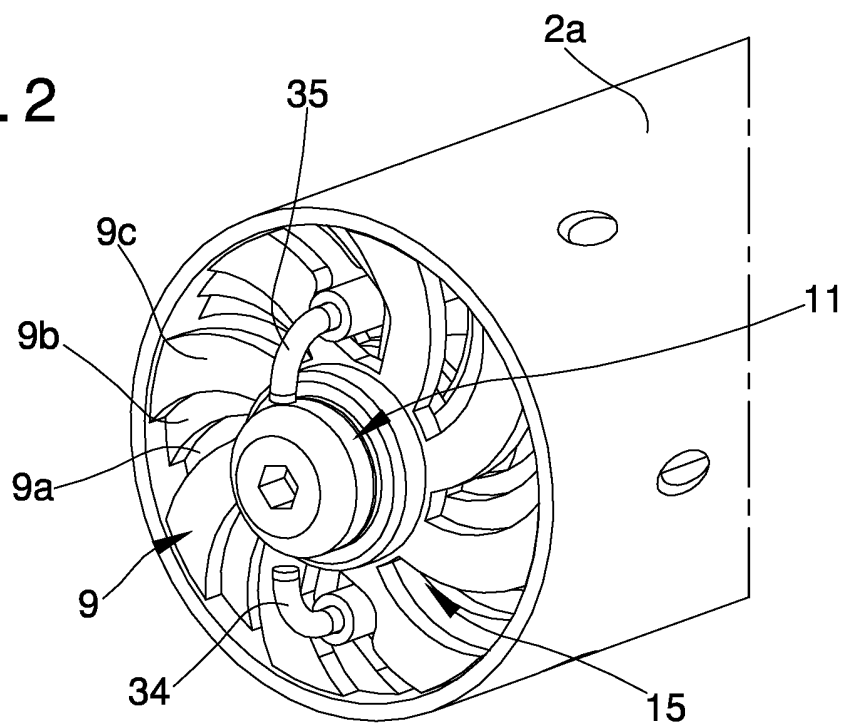


Fig. 3

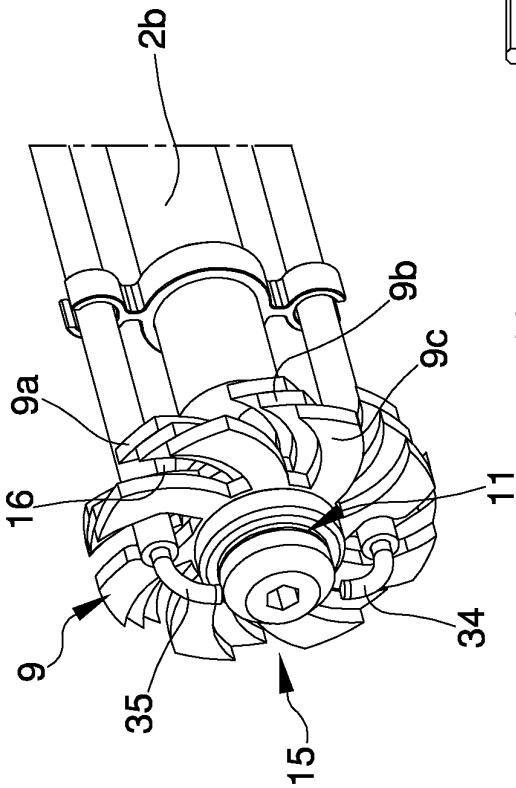
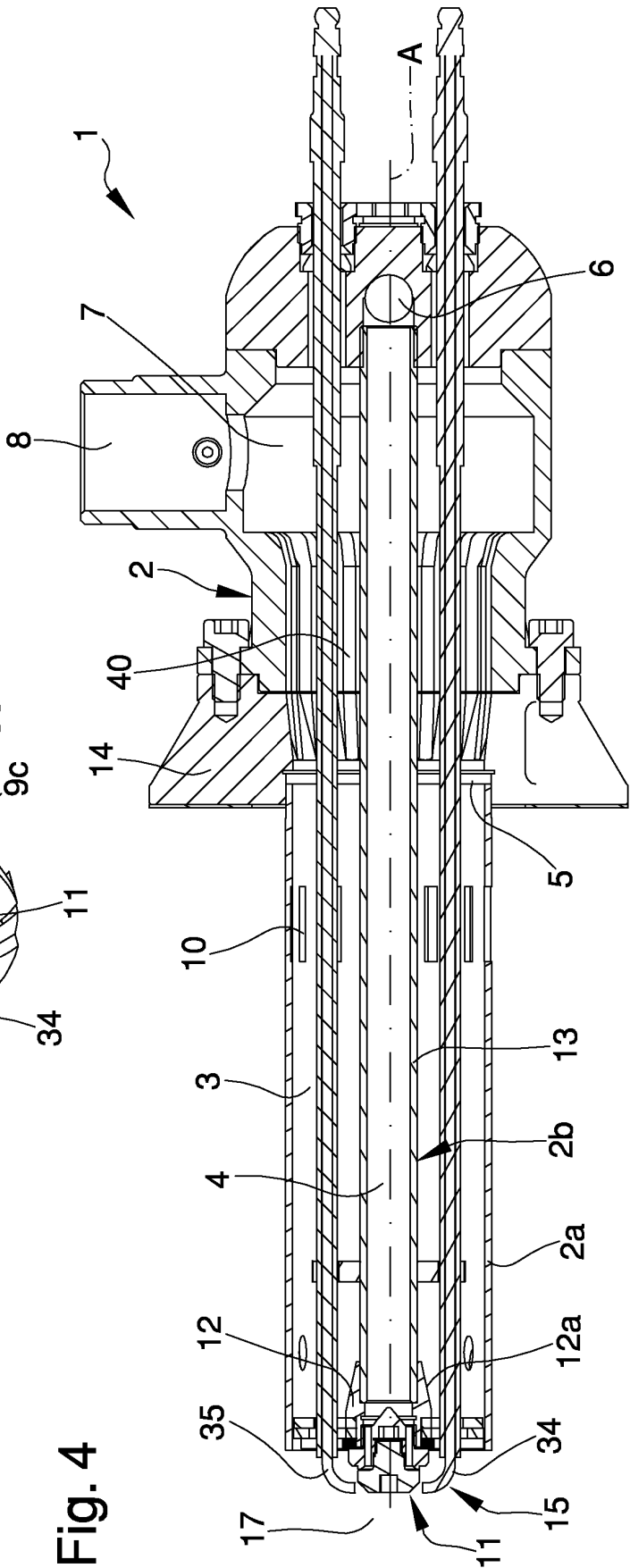
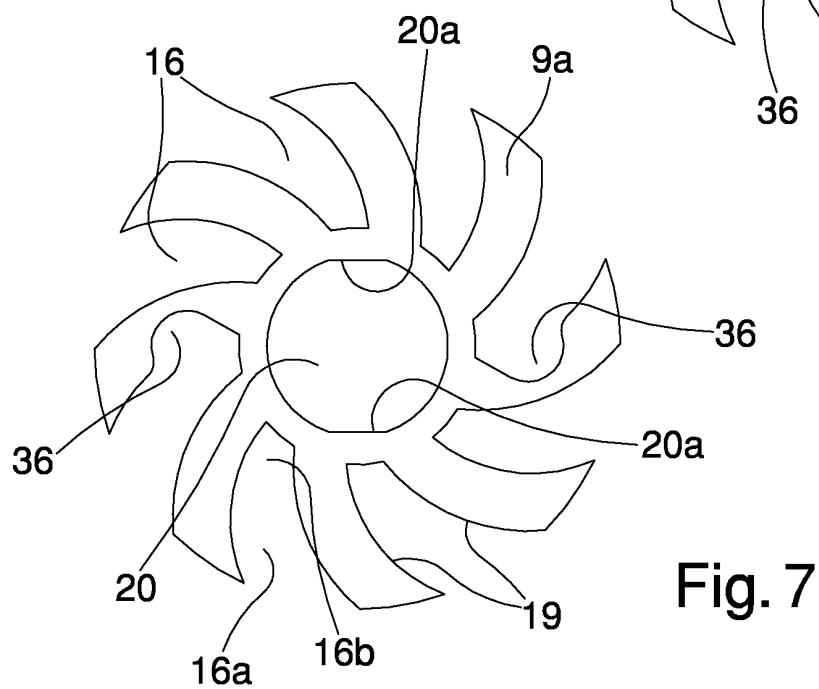
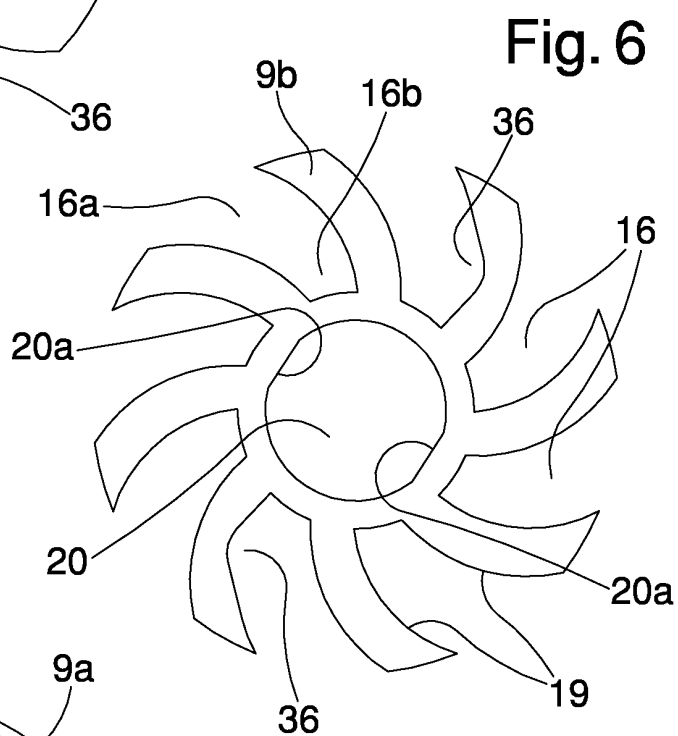
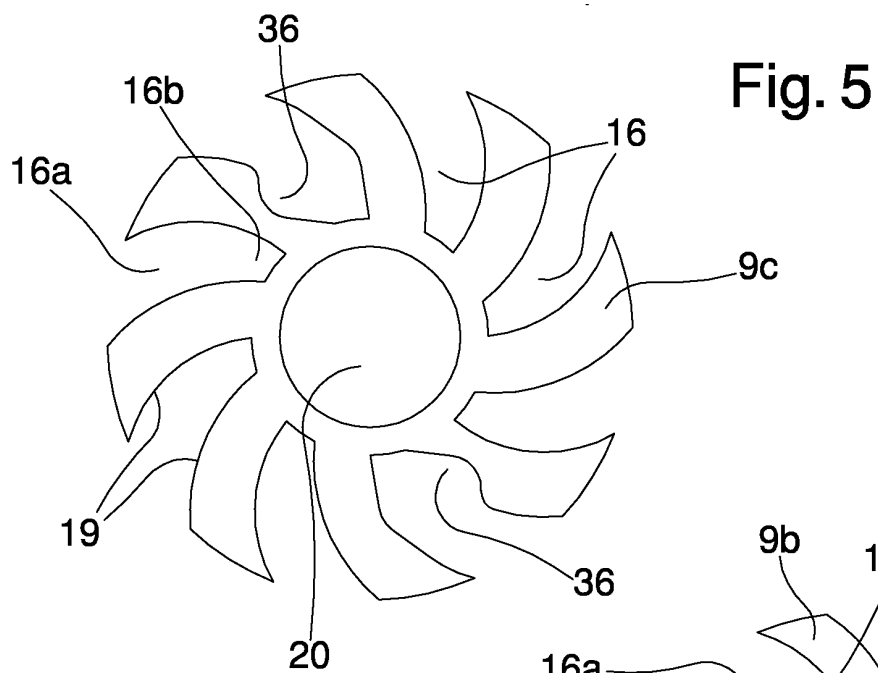


Fig. 4





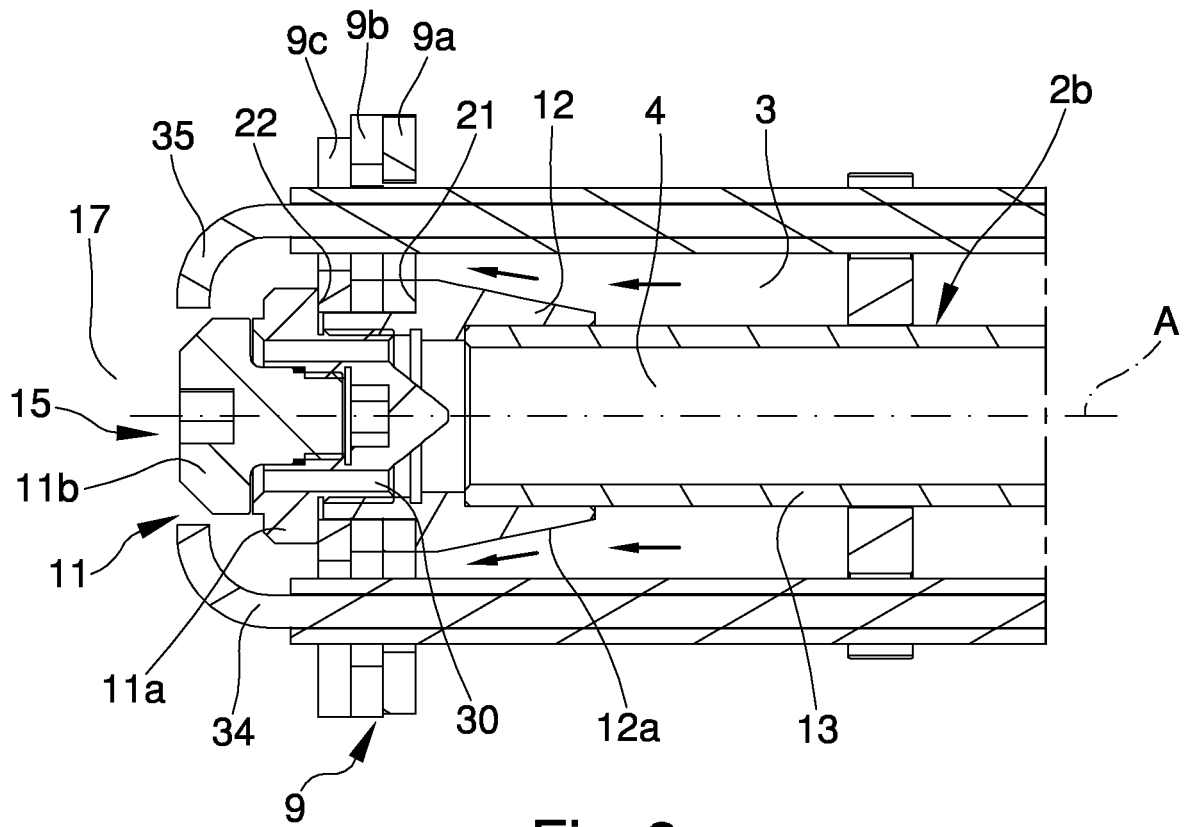


Fig. 8

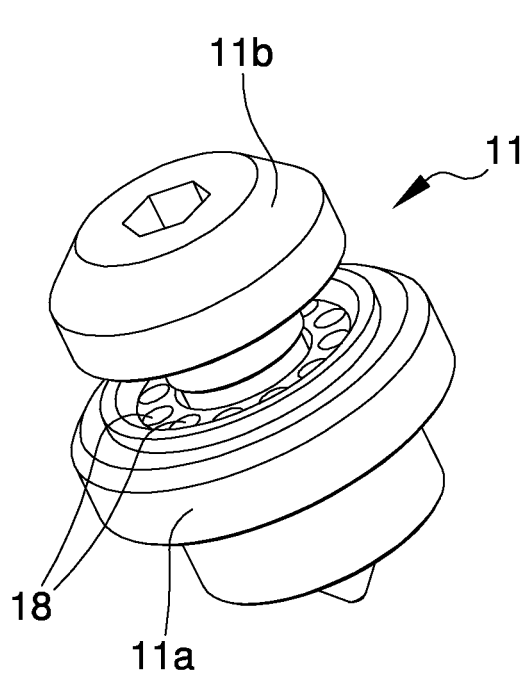


Fig. 9

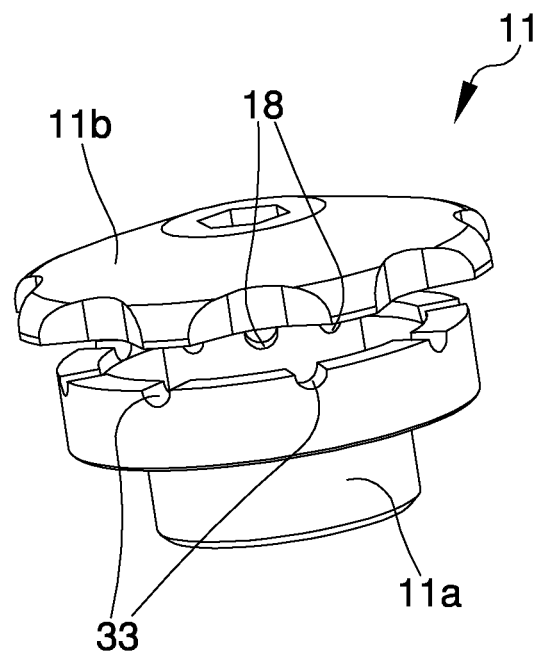


Fig. 11

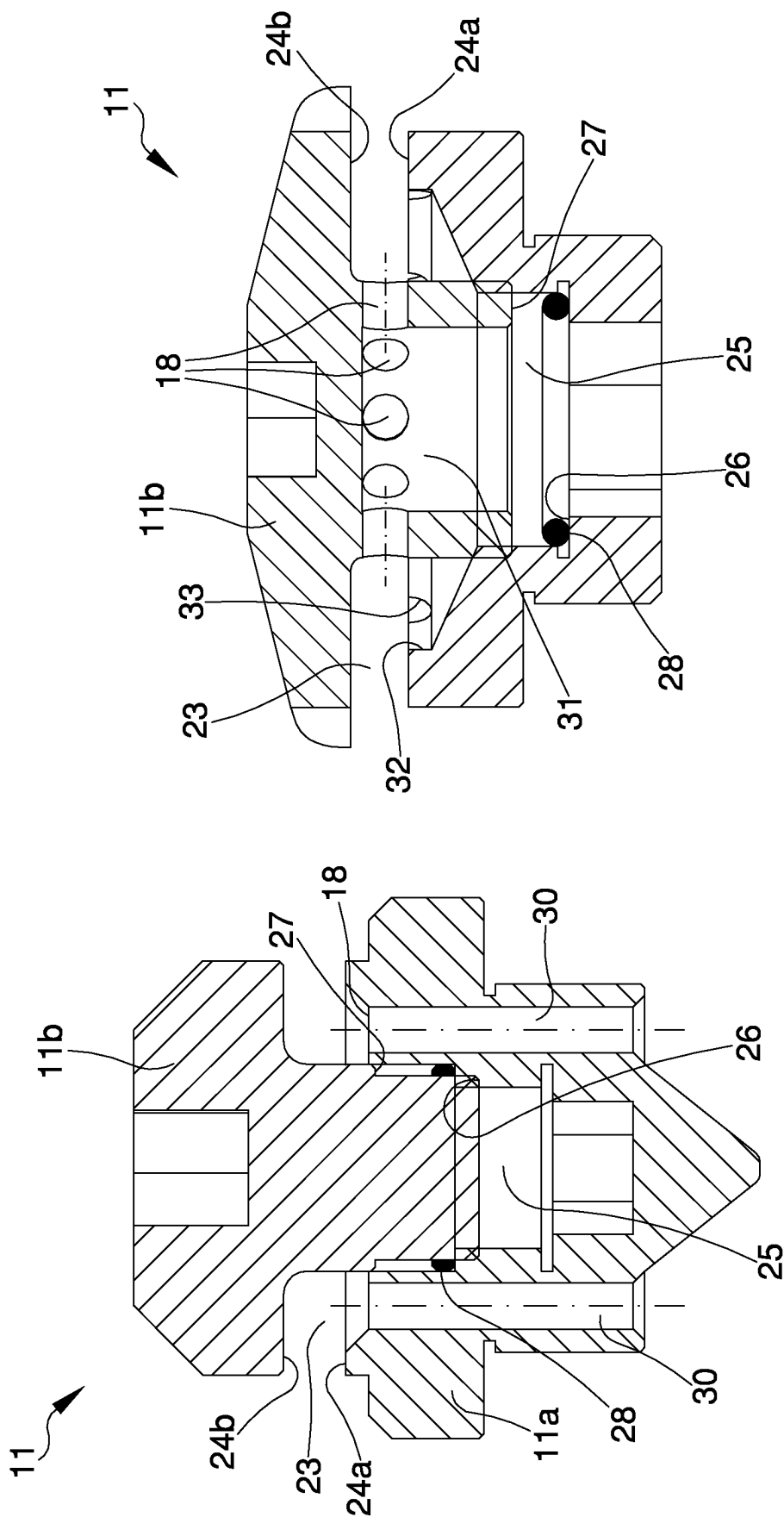


Fig. 12

Fig. 10

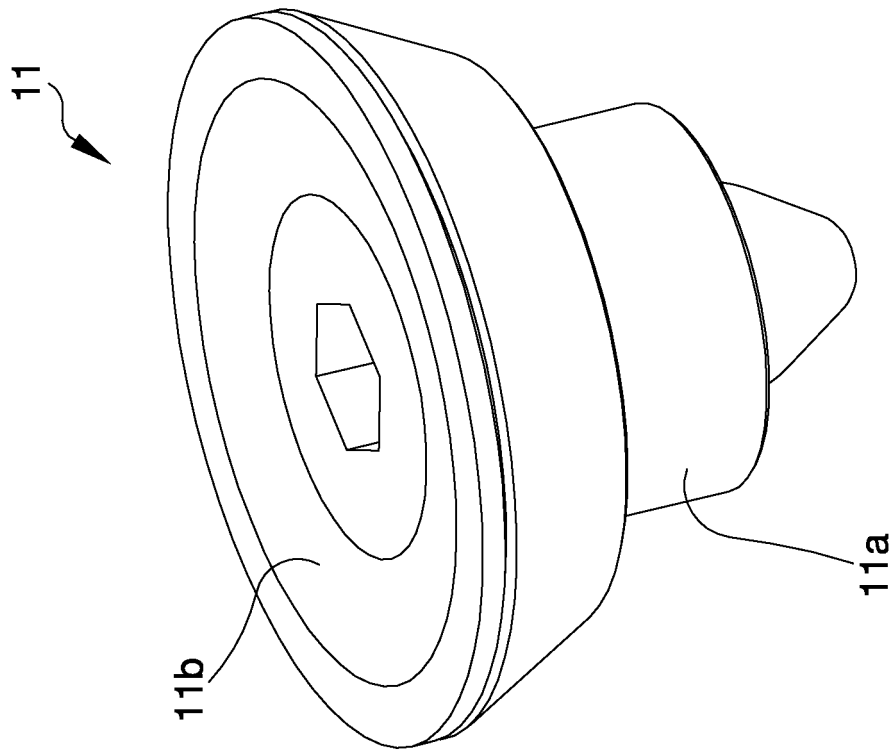


Fig. 13

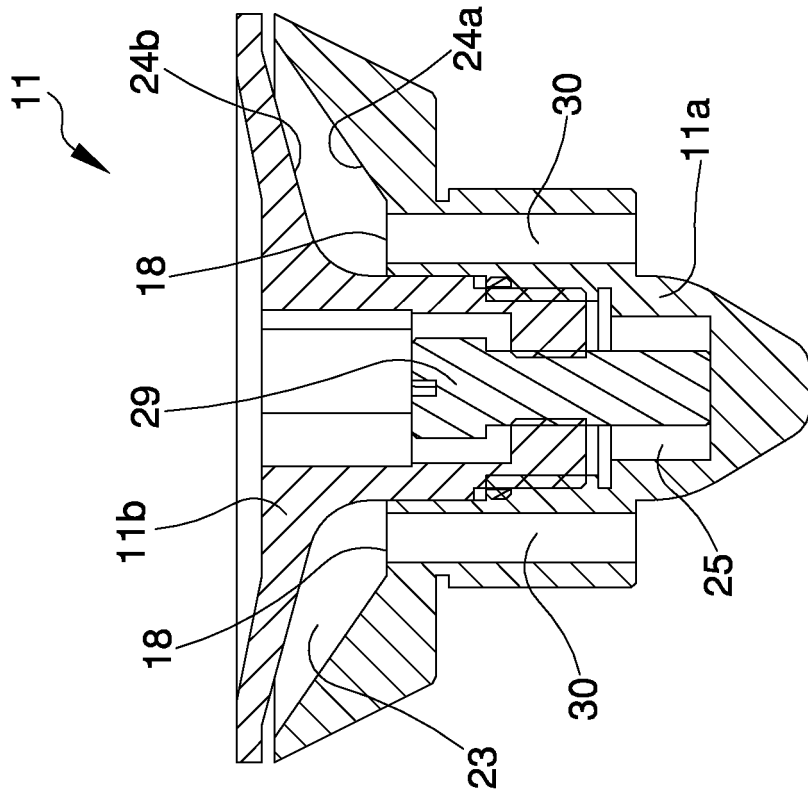


Fig. 14

REFERENCES CITED IN THE DESCRIPTION

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