(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 719 397 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.10.2020 Bulletin 2020/41

(21) Application number: **20167863.8**

(22) Date of filing: **02.04.2020**

(51) Int Cl.:
F23D 14/02 *(2006.01)* ***F23D 14/64*** *(2006.01)*
F23D 14/70 *(2006.01)* ***F23D 14/78*** *(2006.01)*
F23D 99/00 *(2010.01)* ***F23N 5/02*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **03.04.2019 SK 500272019 U**

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(54) **BURNER FOR COMBUSTION OF GASEOUS FUELS IN SHAFT FURNACE, ESPECIALLY FOR HEAT PROCESSING OF MINERALS IN GRANULAR FORM**

(57) The burner is placed inside the burner chamber (1) in a sheath of the shaft furnace and it has a supply pipe (2), which is connected to the source of the gaseous fuel. The burner includes a separation insert (4). The nozzle (3) of the burner is inside the separation insert (4). The second end (9) of the separation insert (4) reaches to the edge zone where the burner chamber (1) is connected to the inside of the shaft furnace. The outer dimension of the separation insert (4) is less than inner dimension of the burner chamber (1). The combustion air enters the inside of the separation insert (4) where it mixes up with the gaseous fuel and subsequently burns, combusts. The nozzle (3) of the burner is placed outside the edge zone; usually it will be placed more than 100 mm, preferably more than 250 mm, from the inner edge of the burner chamber (1). The edge of the burner chamber (1) is protected against the overheating and in the sintering zone of the shaft surface a more homogenous temperature profile is achieved, thanks to which the number of undesired conglomerates and unburned charge is minimalized.

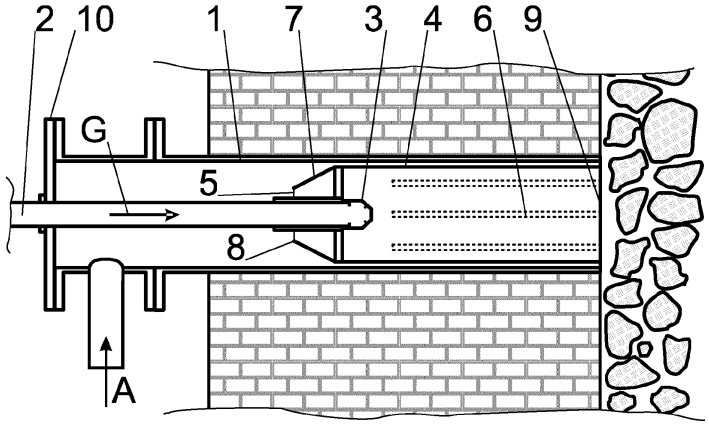

Fig. 1

EP 3 719 397 A1

Description

Field of technology

[0001] The invention concerns a burner for combustion (burning) of the gaseous fuel, for example of natural gas, in a shaft furnace, where the charge is heat processed by direct influence of the flame. The charge, mainly in form of the pulverized mineral, is heated more evenly thanks to combustion in the new burner, whereby it produces fewer dangerous pollutants.

Prior state of the art

[0002] Shaft furnaces which are heated by gaseous fuel use either single central burner or a set of burners which are distributed on the circumference of the furnace. The burner is usually attached on the outer coating of the furnace and the opening for the burner is usually equipped by the furnace lining (inwall, fettling) which creates a chamber. The outlet of the burner with a jet is inside the chamber, at the edge zone, but already before the crossing through the chamber to the space of the shaft furnace so that the burner is not damaged by the movement of the material in the furnace. An air for combustion is led into the chamber and the flame of the burner burns the edges of the chamber at the entry into the space of the furnace, which damages the furnace lining.

[0003] The movement of the burner into the chamber towards the charge partially solves the problems with heat stress of the chamber, but it leads to imperfect combustion which is manifested by the increased amount of CO per m^3 of exhaust gases. Such movement of the burner inside also contributes to uneven melting of the granular charge, where convection is dominant method of heat transfer and convection is then significantly affected by the flame speed profile.

[0004] These opposing problems are partially solved by the burner for processing of minerals pursuant to file CN204434700, where air for cooling is led inside in addition to combustion air, which, however, leads to difficult arrangement from constructional point of view. The burner according to this file protrudes in the space of the furnace, which is problematic in case of horizontally oriented burner in the shaft furnace and leads to mechanical damaging of the burner's mouth by the charge. This problem is partially solved by the arrangement according to publication JPH093561, where the mouth of the burner is inserted inside the chamber, but it still is a complicated constructional arrangement which is prone to failure in a rough metallurgical environment. Solution according to publication EP0660060, where coal dust is combusted alongside gas, is complicated, too.

[0005] Publication EP0302417B1 discloses a method which should prevent the damaging of the chamber lining by means of a central burner with a double construction, which - however - necessitates preparation of two gas mixtures, where first mixture has high heat power and second mixture has low heat power. Such solution is complicated for the purposes of gathering the fuel and it cannot be used in existing chambers with small diameter.

[0006] Such constructionally simple solution of a burner is desired and not known, which will combust gaseous fuel with low emissions, mainly low CO emissions, which will evenly heat the granular charge and which will increase the durability of the burner, burner chamber and lining.

Essence of the invention

[0007] Abovementioned deficiencies are significantly remedied by a burner for combustion of gaseous fuel in a shaft furnace, mainly for heat processing of minerals in granular form, where the burner is placed in a burner chamber in a wall of the shaft furnace and it has a supply pipe (feed pipe) connected to the source of the gaseous fuel; the supply pipe is ended by the burner's jet which is placed outside the edge zone, where the chamber is connected onto the inside of the shaft furnace by the edge zone, whereby forced air supply for the combustion is led into the burner chamber, according to this invention, which essence lies in the fact that it includes an oblong separation insert; at least one opening of the combust air which connects the supply of the air with the inner space of the separation insert is created between the supply pipe and the separation insert, whereby the second end of the separation insert reaches to the edge zone and the outer dimension of the separation insert is smaller than the inner dimension of the chamber.

[0008] The terms "first" and "second" in this text differentiate between two opposite sides of the body; they do not denote the difference in importance and they are mutually interchangeable. The term "first" is assigned to the side which is first from the direction of flow of combust air and also from the direction of gaseous fuel.

[0009] The term "separation insert" denotes any body, pipe, cylinder, casing, shell, which has continuous outer sheathing capable of separating the branches of air flow or flue gases, respectively, in the burner chamber. The term "insert" itself should be understood broadly and there is a possibility of subsequent insertion of this insert into existing burner constructions.

[0010] The shape of transversal cross-section of the separation insert corresponds to the cross-sectional shape of the burner chamber; usually it has a shape of the circle with irregularities which correspond to the particular type of furnace lining. The separation insert will in most cases have a shape of cylindrical casing, usually it will be produced from steel, preferably from the from heat-resistant steel. The outer diameter of the cylindrical separation insert is less than inner diameter of the burner chamber, preferably the outer diameter of the cylindrical separation insert is smaller by at least 20 mm than the inner diameter of the burner chamber, so that the cross-sectional profile is sufficient for the flow of the air between the outer surface of the separation insert and the inner

surface of the burner chamber.

[0011] The significant feature of the proposed invention is the creation of the separated profiles of flow within the burner chamber during forced intake of the air into the burner chamber. A pipe usually serves for air intake, which is connected through a pipe bend or T-shaped pipe piece to the outer side of the burner chamber. A burner is inserted into the burner chamber by means of a flange on the pipe bend or T-shaped pipe piece, whereby it is carried by supply pipe as a carrier fixed in the flange. The air blown into the burner chamber is distributed in such a way that part of the air runs at least through one opening between the supply pipe and separation insert and runs into the inner space of the separation chamber where there is burner's nozzle. It is preferable if the separation insert, supply pipe and burner's nozzle are within a single axis or if their axis differ within no more than constructional and installation margins of error, respectively.

[0012] The air brought inside the separation insert is primarily mixed with the gaseous fuel emerging from the burner's nozzle; the mixture of air and gaseous fuel is subsequently burned in such a way that combustion takes place inside the separation barrier and then proceeds inside the shaft furnace where the flame directly traverses and it operates directly within the granular charge. Inside the shaft furnace the burning out of the gaseous fuel is supported by the air which runs around the separation insert and until this phase it only served the function of cooling of the surface of the burner chamber. This air branch also cooled the outer surface of the separation insert in order to avoid its overheating and mechanical collapse. The air which flows and cools the outer surface of the separation chamber is at the same time pre-heated before the entry into the combustion space within the furnace.

[0013] The burner's nozzle is placed outside the edge zone by which the chamber is connected to the inside of the shaft furnace; usually it will be present more than 100 mm, preferably more than 300 mm, from the edge of the chamber. The length of the separation insert will correspond to this; said length reaching from before the burner's nozzle to the edge zone of the chamber, preferably to the edge of the chamber itself. In the inner space the flowing gaseous fuel and flowing combustion air are firstly mixed, then combusted, whereby within the length of the chamber there is no direct operation of the flame onto the lining of the chamber. This is significantly manifested by the increase in the durability of the chamber's lining.

[0014] The forced blowing of the air into the burner chamber according to this invention leads to flow around the outer side of the separation insert. Thanks to this the surface of the burner chamber is effectively cooled even in the edge zone, where hitherto critical heat load arose. The air flowing around the outer side of the separation insert enters on its other side into the contact with the burning flame, where it can support the second degree of the burning of the gaseous fuel. The secondary combustion air before the burning inside the shaft furnace is subsequently used for cooling.

[0015] An important advantage of the proposed invention is the usability of the burner in existing shaft furnaces without the need for their modification and without the need to modify the air distribution. The existing air distribution is construed without the separation of the combustion air and air for cooling of the surface of the burner chamber. In this invention it suffices to dismount the existing burner and mount the new burner with separation insert onto the same flange, where the burner is inserted into the burner chamber in such a way that the nozzle is outside the edge zone and the space from before the nozzle all the way to the edge zone is covered by the separation insert. The separation of the combustion air and the air for the cooling of the surface of the burner chamber takes place only thanks to the new construction of the burner. In order to set the flow ratios of these two branches of flow, a cross-sectional geometry of the first end of the separation insert is preferably used. It is preferable if the opening for the combustion air is formed by the space between the outer surface of the supply pipe and inner opening of the first end of the separation insert.

[0016] In the process of inventing of the proposed invention it proved preferable that the first end of the separation insert has conical shape which then follows into the cylindrical body continuing towards the other end of the separation insert. The conical shape diminishes the throttling of the flowing air and directs the air flow towards the surface of the burner chamber. At the beginning of the separation insert there can be connecting elements, for example at least three screws, through which the separation insert is connected to the supply fuel pipe. The annular (intercircular) space delimited by the outer surface of the supply pipe and the outer opening of the first end of the separation insert forms an opening for the combustion air into which the screw shafts protrude. Such solution proved to be simple and sufficiently stable; the screws after release do not prevent the dismantling of the burner and the burner's nozzle can, during the dismantling, pass through the opening of the first end of the separation insert without any problems.

[0017] The improved effect and higher durability of the separation insert is achieved by an arrangement where the separation insert has ribs alongside its outer surface. The ribs are, in the preferable arrangement, distributed in regular intervals and they are parallel with the longitudinal axis of the separation insert. A rib's length is at least 20%, preferably 40%, of the length of the separation insert. The ribs not only direct the air flow, but they increase the mechanical and heat resistance of the separation insert, too, preventing excessive deformation of the insert, since such deformations arise as a result of thermal expansion. The uneven thermal field during the burning, combined with the turbulent gas flow, can lead to rotation and deviation of the body of the separation insert; the ribbing helps to increase the solidity of the separation insert. In case of excessive deformation which leads to leaning of the separation insert against the surface of the

chamber, the ribs ensure that there remains a gap between the separation insert and the surface of the chamber. The ribs increase the effective heat-transferring surface, too, and help to center the burner in the chamber during the mounting. The outer diameter of the separation insert together with the ribs is smaller, or at most the same, as the inner diameter of the burner chamber.

[0018] The possibilities of setting of the burning capabilities of the burner lie mainly within the design of the dimensions of individual parts of the chamber. A gas and air flow being given, the choice of the inner diameter of the cone relative to the diameter of the burner chamber and to the diameter of the supply gas pipe, has significant influence. The design of the dimensions of the cross-section of the annulus between the sheath of the separation insert and the inner surface of the burner chamber is likewise important. The size of the annulus is related to the choice of the ribs' height, too.

[0019] The placement of the nozzle within the length of the burner chamber also influences the features and shape of the combustion zone. An arrangement proved preferable where the nozzle with the openings for the gas is placed in the zone delimited by the length of 25% to 80% of the thickness of the shaft furnace's walls in the direction from outside to inside, which corresponds to the distance of the nozzle being 100 to 1500 mm from the inside of the shaft furnace. This length (compared to 50 mm in the prior art) causes a significant homogenization of the combustion even before the contact of the flue gases with the charge. Subsequently, the burning out of the gas in the charge allows for the secondary, cooling air which flows between the separation insert and the inner surface of the combustion chamber.

[0020] A suitable choice of geometry of individual parts of the separation insert leads to simple construction with high reliability and durability. In order to be able to alter flow rations, some elements of the separation insert can have changeable geometry, for example, the opening of the combustion air can be equipped by a shade (screen, diaphragm) with changeable throttling.

[0021] In order to improve the regulation capabilities of the burner, this can have independent supplies of the air inside the separation insert and air into the gap between the separation insert and the inner surface of the burner chamber. In such arrangement the amount of the primary combustion air and amount of the cooling combustion air flowing around the separation insert from the outside can be independently regulated. In preferable arrangement, the burner can be equipped by temperature sensor, for example, by infrared temperature sensor, whose head is placed in the cold zone, for example, on the outer flange of the burner chamber. The measurement of the temperature in the edge zone allows to evaluate the process of burning and subsequently the temperature fields can be regulated by changing the amount of the secondary air.

[0022] During the tests of the burner according to this invention in the existing shaft furnace with the original air and natural gas distribution it was determined that CO emissions decrease from 4000 $mgCO/m^3$ below 2000 $mgCO/m^3$. The edge of the chamber showed no marks of overheating and more homogenous temperature profile was achieved in the sintering zone of the shaft furnace, thanks to which the number of undesired conglomerates and unburned charge decreased. A significant advantage of the proposed invention is optimization of contradictory parameters of heat processing of granular charge without interventions into the construction of the existing shaft furnace. In particular, CO emissions decrease while simultaneously the thermal wear of the burner chamber decreases, too.

[0023] Constructionally simple and operationally reliable separation insert limits the inflow of the combustion air to the space with the nozzle, it creates a self-regulating volume of the combustion zone in the inner space of the separation insert and it also directs the flow of the air which cools the surface of the chamber. Aside from the above mentioned technical advantages, the advantage of the solution is its simple use in the existing shaft furnaces without the need for costly and difficult modifications of the construction of the existing shaft furnace and air distributions.

Brief description of drawings

[0024] The invention is further disclosed by means of drawings 1 to 5. The depicted shape of the separation insert, the method of its attachment as well as dimensional ratios of individual parts of the burner are only examples which cannot be interpreted as features limiting the scope of protection.

Figure 1 is a cross-section of the burner chamber of the shaft furnace with the inserted burner. The arrow with letter A denotes the inflow of air; arrow with letter G denotes the inflow of gas.

Figure 2 is axonometric view of the weldment of the separation insert without a nozzle.

Figure 3 depicts the weldment of the separation insert without the nozzle from the side; subsequently, figure 4 is cross-section of the weldment of the separation insert in points A-A.

Figure 5 depicts a burner chamber of the shaft furnace with the inserted burner, where there are two independent branches of the intake air for the combustion inside the separation insert and for the air flowing around the outer surface of the separation insert.

Examples of realization

Example 1

[0025] In this example according to figure 1 a burner is used in the shaft furnace for the thermal processing of the magnesite ore milled into the granular form. The shaft furnace has multiple burner chamber 1 alongside its circumference, with burners inserted inside the shaft furnace's walls. The original construction includes the forced supply air distribution through the pipe alongside the circumference of shaft furnace's sheath. The pipe is placed below the burner chamber 1 level. A branch line from the air pipe towards the burner chamber 1 is formed below the chamber 1; the branch line ends with T-shaped piece. One branch of the T-shaped piece leads into the burner chamber 1, the other branch of the T-shaped piece forms a flange end designed for the screwing of the flange 10 of the burner. This arrangement forms an original construction which is used without modifications for the cooperation with the new burner according to this invention. This brings about the advantage of minimal modifications during the mounting of the burner according to this invention.

[0026] The burner involves a supply pipe 2 mounted into the flange 10 designed for the screwing of the flange end to the T-shaped piece. The supply pipe 2 is gastightly connected with the flange 10 and this joint carries the weight of the burner inserted into the carrier. On the other side the supply pipe 2 is ended by the nozzle 3 which in this example is formed by the ending with six openings. The openings in the nozzle 3 are led evenly and radially into the space in an angle which is 45° from the horizontal axis. The position of the nozzle 3 inside the burner chamber 1 is determined by the length of the supply pipe 2 from the flange's 10 plane; the position of the nozzle 3 in this example is set in such a way that the nozzle 3 is present at least 150 mm from the edge of the burner chamber 1.

[0027] The burner has a separation insert 4, whose body is welded from several parts of heat-resistant steel, preferably STN 17255 steel. The weldment has oblong shape. The first end 8 involves a cone 7 with short collar which has three openings with the threads for the screws. The inner dimension of the first end 8 - that is, the inner diameter of the collar and the conical part - is more than the inner diameter of the supply pipe 2 and the gap between them forms the opening 5 for the combustion air. By means of the connecting elements - in this case, three screws - the separation insert 4 is connected, and it is centered against the supply pipe 2. The cylindrical body of the separation insert 4 follows upon the cone 7. The cylindrical part continues to the edge zone of the chamber 1, where it forms the second end 9.

[0028] Ribs 6 from the strap are welded evenly on the outer cylindrical surface of the separation insert 4. In this example, the separation insert 4 has 10 ribs 6 reached all the way to the second end 9.

[0029] In this example, the burner chamber 1 has diameter of ca. 98 mm. In the original construction of the burner, the furnace lining in the edge zone of the chamber 1 was thermally destroyed already with the nozzle's 3 position being 50 mm from the edge of the chamber 1. Use of the new burner according to this invention increases the nozzle's 3 distance from the edge of the burner chamber 1, prolongs the course of the mixing of the natural gas with the combustion air, significantly decreases the CO emissions and, at the same time, thermally processes the charge more regularly and evenly.

Example 2

[0030] In this example according to figure 3 the supply pipe 2 is slidably placed in the socket which is welded to the flange 10. The placement is sealed by the couple of sealing rings (O-rings). This connection transfers the weight of the inserted burner into the flange 10 and, at the same time, allows to alter the position of the nozzle 3 in the chamber, that is, it allows to change the distance of the nozzle 3 from the edge of the chamber 1.

[0031] A sheet metal screen (shade, diaphragm) is placed in the opening 5 for the combustion air; this screen allows to change the effective cross-section of the inflow of the combustion air inside the separation insert 4.

Example 3

[0032] In this example, the separation insert 4 is composed from three parts which are subsequently welded into a single body. The three parts in this example are defined as sheath 11, cylindrical pipe 12 and cone 7. The middle part consists of cylindrical pipe 12, in the center of which the cylindrical hub 13 is placed. The axis of the cylindrical hub 13 is basically identical with the axis of the cylindrical pipe 12; the axes can angularly and dimensionally differ within a common margin of error from the production. The hub 13 is welded to the three centering wings 14, which are in this example trapezoidally shaped. The winds 14 are welded to the outer circumference of the hub 13 in angularly identical pitch and on the other ends they are welded to the inner surface of the cylindrical pipe 12. In another example another number of the wings 14 can be used, or entirely different carrier element can be used, which would ensure the centric placement of the nozzle within the cylindrical pipe 12.

[0033] The cylindrical pipe 12 in this example is short; it corresponds approximately to the length of the hub 13 so that the joints can be welded by common welding equipment which otherwise could not have been inserted into the long cavity with small diameter. After the hub 13 is welded in center of the cylindrical pipe 12, the cylindrical sheath 11 of the burner with the ribs 6 is welded to one front of the cylindrical pipe 12. The ribs 6 are welded on the sheath 11. In this example, the ribs 6 have 4 x 6 mm cross-section and they reach from the end of the separation insert 4 to approximately a middle of the length

of the separation insert 4. The number of ribs 6 in this example is 10 and they are evenly angularly distributed alongside the circumference. On the other side the cone 7 is welded to the cylindrical pipe 12 with the centered hub 13. The cone 7 has outer diameter identical with the diameter of the cylindrical pipe 12 with which it is circumferentially welded, and towards the opposite end the cone 7 is narrowed to a diameter which is more than the outer diameter of the gas supply pipe 2, which produces a cross-section of an annulus through which the air is blown towards the nozzle 3. This annulus forms an opening 5 for the combustion air.

[0034] The outer diameter of the sheath 11 including the ribs 6 in this example is approximately 1 mm less than the inner diameter of the burner chamber 1 which allows for easy insertion of the burner into the burner chamber 1 and eventual permanent deformations caused by heat do not case problems during the burner's dismantling. The ribs 6 ensure the creation of a gap between the burner and the inner surface of the burner chamber 1, which protects the lining in the thermally critical place. The air blow into the burner chamber flows to the nozzle 3 not only through annulus, but it is also directed by the cone 7 into the space between the sheath 11 and the inner surface of the burner chamber 1 which cools the furnace lining of the wall by the burner chamber 1. This air does not enter into the process of burning in the burner chamber 1, but only inside the charge, which both increases and evens out the combustion zone.

[0035] After the welding of the separation insert 4 the weldment is attached for the gas supply pipe 2 in such a way the end of the supply pipe 2 with the thread is inserted to the centered cylindrical hub 13 from the side of the cone 7 and the nozzle 3 is screwed from the opposite side. The mounting on the nozzle's 3 body leans onto the front of the cylindrical hub 13. This arrangement achieves fixation of the burner onto the burner to the gas supply pipe 2. During the montage the supply pipe 2 is led in the opening of the flange 10 which closes the burner chamber 1 from outside. The nozzle 3 in this example has eight openings through which the natural gas flows out under the pressure of the air.

[0036] In this example, the nozzle 3 is placed approximately 30 mm from the outer edge of the shaft furnace.

Example 4

[0037] In this example according to figure 5 the original air distribution is attached in such a way that the two branches of forced air supply with independent regulation valves are produced. The first branch leads the air inside the separation insert 4, the second branch is connected into the gap between the separation insert 4 and the inner surface of the burner chamber 1. The head of the infrared thermometer is placed on the flange 10.

[0038] Thanks to the independent regulation of two branches of air the volume of the cooling secondary air can be altered while the stoichiometric ratio of the air during burning inside the separation insert 4 is maintained.

Industrial applicability

[0039] Industrial applicability is obvious. Thanks to this invention it is possible to industrially and repeatedly produce the burner for combustion of the gaseous fuel and use it in shaft furnace, mainly in shaft furnaces for thermal processing of the minerals in granular form, where the flames act directly onto the charge.

List of symbols

[0040]

1 - chamber
2 - supply pipe
3 - nozzle
4 - separation insert
5 - opening for combustion air
6 - rib
7 - cone
8 - first end
9 - second end
10 - flange
11 - sheath
12 - cylindrical pipe
13 - hub
14 - wing

Claims

1. A burner for a combustion of a gaseous fuel in a shaft furnace, mainly for a heat processing of minerals in a granular form, where the burner is place in a burner chamber (1) in a sheath of the shaft furnace and it has a supply pipe (2) which is connected to a source of the gaseous fuel; the supply pipe (2) is ended by a nozzle (3) which is placed outside an edge zone through which the burner chamber (1) is connected to an inside of the shaft furnace, whereby a forced air supply for the combustion is led to the burner chamber (1)
is characterized by the fact, that
it includes a separation insert (4) which is mounted onto the supply pipe (2) by its first end (8) in such a way that the burner's nozzle (3) is inside the separation insert (4);
second end (9) of the separation insert (4) reaches to the edge zone; a gap for a flow of an air towards the shaft furnace is between the separation insert (4) and the inner surface of the shaft furnace (1);
whereby the air supply is led inside the separation insert (4) and to an outer surface of the separation insert (4).

2. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to the claim 1 **is characterized by the fact**, that between the supply pipe (2) and the separation insert (4) at least one opening (5) for the combustion air is produced, whereby this opening (5) connects the forced air supply with the inner space of the separation insert (4).

3. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to the claim 1 **is characterized by the fact**, that it has independent supplies for the air flowing inside the separation insert (4) and for the air flowing inside the gap between the separation insert (4) and the inner surface of the burner chamber (1).

4. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 3 **is characterized by the fact**, that a shape of a cross-section of the separation insert (4) corresponds to a cross-sectional shape of the burner chamber (1); preferably the separation insert (4) has circular cross-section.

5. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 4 **is characterized by the fact**, that the gap between the separation insert (4) and the inner surface of the burner chamber (1) is at least 10 mm, preferably at least 20 mm.

6. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 5 **is characterized by the fact**, that the nozzle (3) is distanced from the inner edge of the chamber (1) by at least 100 mm, preferably by at least 250 mm.

7. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 6 **is characterized by the fact**, that the separation insert (4) has on its first end (8) a cone (7) upon which a cylindrical pipe (12) and a sheath (11) follow, whereby the sheath (11) reaches to the second end (9).

8. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to the claim 7 **is characterized by the fact**, that the separation insert (4) includes a hub (13) designed for mounting onto the supply pipe (2), whereby the hub (13) is fixed inside the cylindrical pipe (12) by at least one wing (14).

9. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 8 **is characterized by the fact**, that the separation insert (4) has at least three ribs (6) oriented in a direction of a longitudinal axis on its outer surface.

10. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to the claim 9 **is characterized by the fact**, that the ribs (6) reach from the second end (9) to at least 20% of a length of the separation insert (4), preferably to at least 40% of the length of the separation insert (4).

11. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 10 **is characterized by the fact**, that the separation insert (4) is a weldment, preferably the weldment made of a fireproof steel.

12. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1, 2, 4 and 11 **is characterized by the fact**, that a flow cross-section of the opening (5) for the combustion air on the first end (8) reaches to 40% of the cross-section of the burner chamber (1).

13. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 12 **is characterized by the fact**, that the opening (5) for the combustion air has variable geometry.

14. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 13 **is characterized by the fact**, that the supply pipe (2) is connected with a flange (10) which is mounted into an air distribution within an axis of the burner chamber (1); preferably the connection of the flange (10) with the supply pipe (2) is slidable and mutually sealed by at least one sealing ring.

15. The burner for the combustion of the gaseous fuel in the shaft furnace, mainly for the heat processing of the minerals in the granular form, according to any of the claims 1 to 14 **is characterized by the fact**, that it includes a temperature sensor in the edge

zone, preferably the optical temperature sensor.

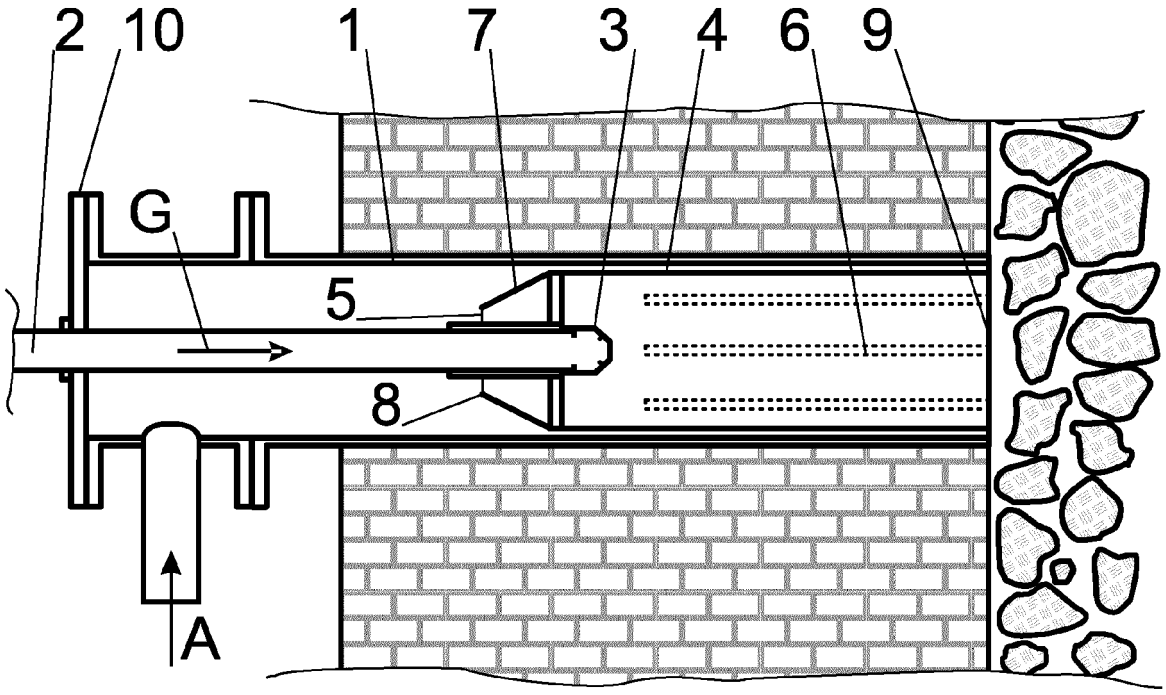

Fig. 1

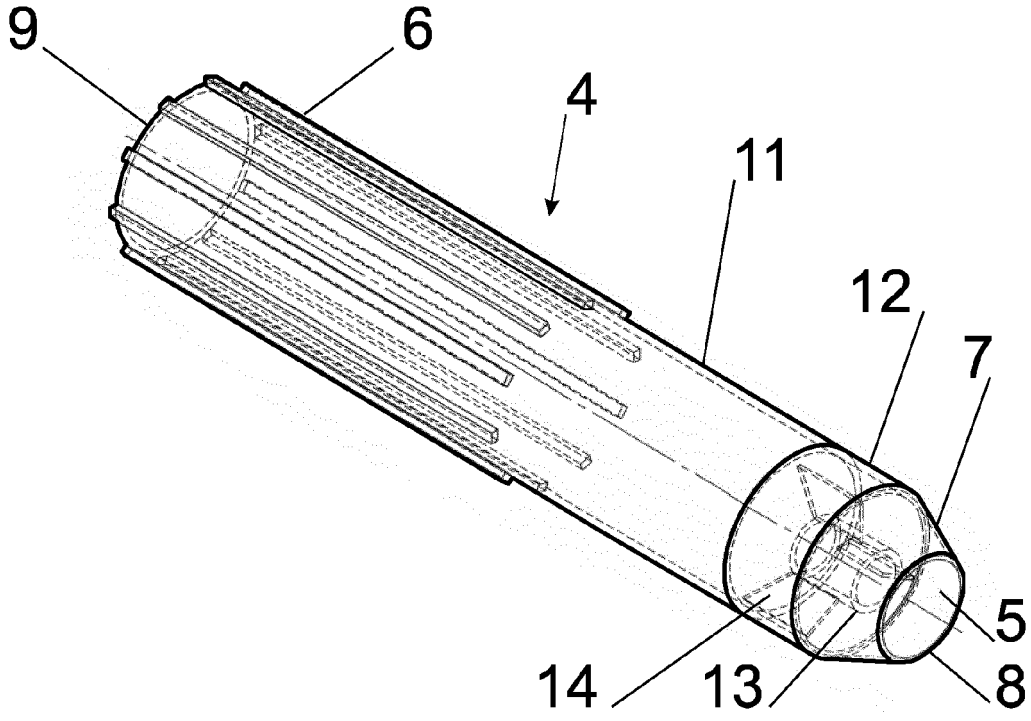

Fig. 2

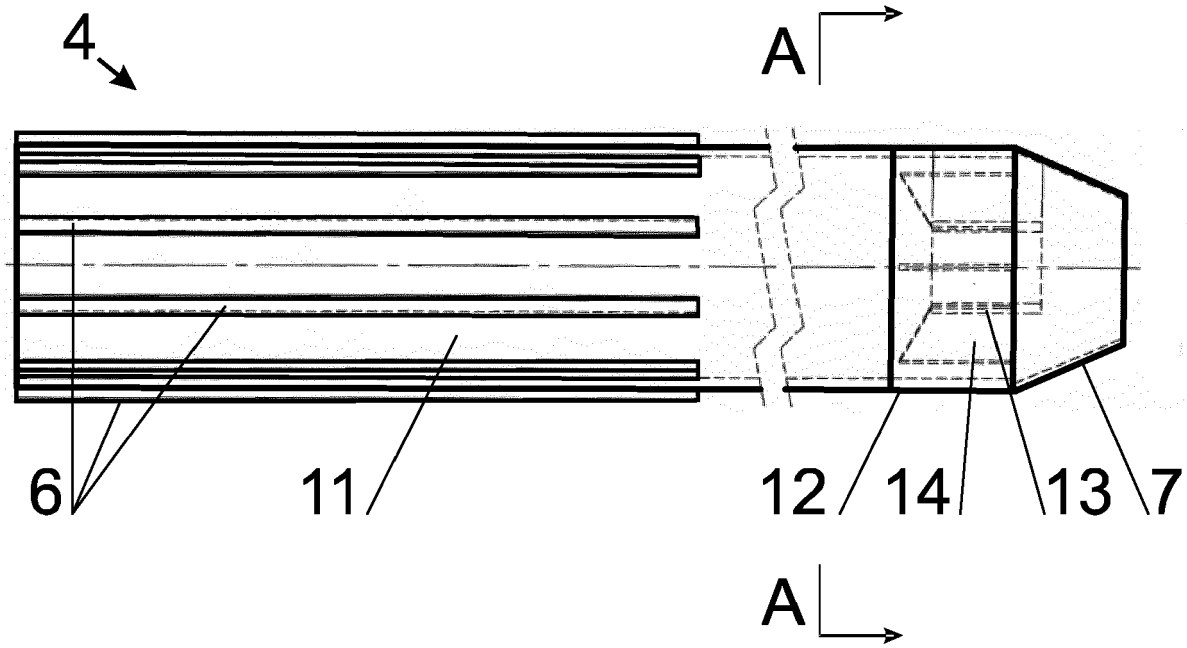

Fig. 3

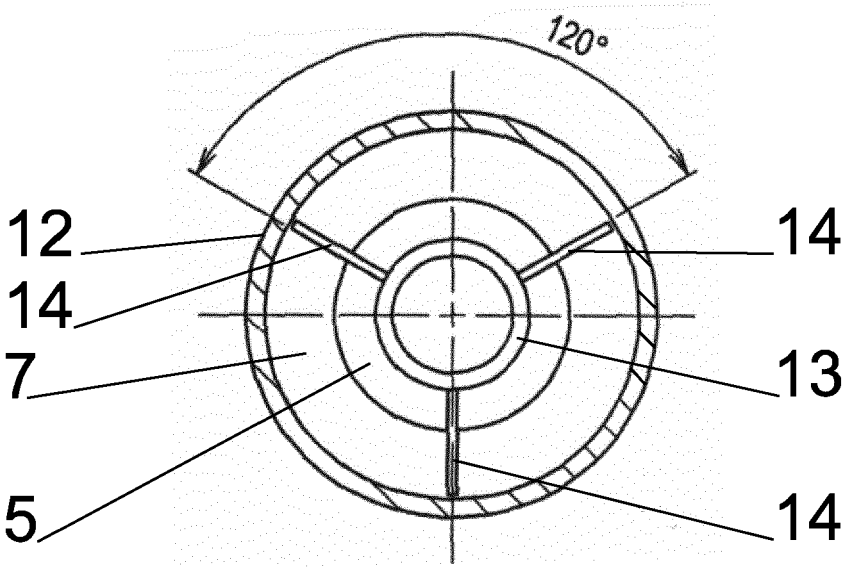

Fig. 4

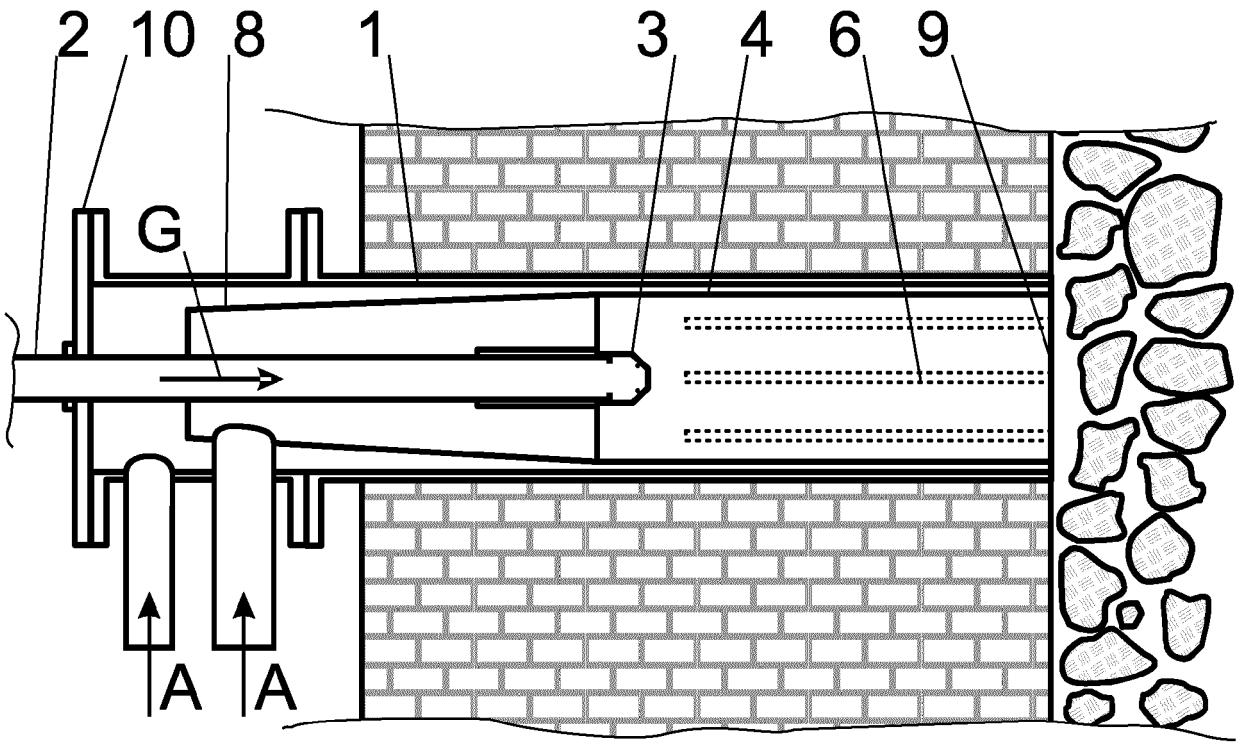

Fig. 5

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EUROPEAN SEARCH REPORT

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Place of search	Date of completion of the search	Examiner
Munich	24 July 2020	Gavriliu, Costin

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