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

(11) Publication number: **0 459 963 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **30.08.95** (51) Int. Cl.⁶: **D21C 11/12**

(21) Application number: **91850130.5**

(22) Date of filing: **16.05.91**

(54) **Process for partial combustion of cellulose spent liquor.**

(30) Priority: **31.05.90 SE 9001958**

(43) Date of publication of application:
04.12.91 Bulletin 91/49

(45) Publication of the grant of the patent:
30.08.95 Bulletin 95/35

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

(56) References cited:
SE-C- 137 938

(73) Proprietor: **CHEMREC AKTIEBOLAG**
P O Box 44
S-182 11 Danderyd (SE)

(72) Inventor: **Stigsson, Lars**
Montelinvägen 22
S-237 00 Bjärred (SE)

(74) Representative: **Barnieske, Hans Wolfgang**
c/o H. W. Barnieske Patentbyra
P.O. Box 25
S-151 21 Södertälje 1 (SE)

EP 0 459 963 B1

Description

Technical field

The present invention relates to a process for partial combustion of cellulose spent liquors from the cellulose industry in a burner connected to a reactor, which burner comprises a centrally arranged burner gun or liquor lance equipped with a nozzle at its front end which adds liquor and, a coaxially arranged tubular channel around the liquor lance, in which channel an oxygen containing gas is added to support partial combustion, whereby the oxygen containing gas, prior to entry in the coaxially arranged channel, has been given a vortex movement.

The object of the present invention is to facilitate partial combustion of the cellulose spent liquor through use of a burner creating a stable, self-igniting flame at low air/fuel ratios.

Background of the invention

The cellulose industry generates spent liquors differing in composition according to the delignification process used. Within the sulphate pulping industry, spent liquor, commonly referred to as black liquor, contains valuable chemicals and energy in the form of combustible carbonaceous compounds. At the present time these chemicals and energy are normally recovered in a recovery boiler in which the black liquor is completely burned.

Partial combustion of black liquor in a gasification reactor as in the present invention generates a combustible gas comprising H_2, CO, CO_2, and droplets of molten inorganic chemicals.

SE-C-137 938 shows a process according to the introductory part of claim 1.

In conjunction with pulp bleaching, a diluted liquor comprising organic matter and sodium salts is obtained. Mechanical and semi-chemical pulping processes also generate diluted liquors of different compositions. These as well as other waste and spent liquors generated in the cellulose industry can, after concentration, be used as a feedstock in the process of the present invention.

Although the following description describes the present invention as it applies to black liquor it is not restricted only to this particular liquor in its application.

The mechanisms related to partial combustion of black liquor are fairly well understood and are applied inter alia in the lower part of the soda recovery boiler. The difference between the present burner and a liquor burner in a soda recovery boiler is, however, great inter alia due to the low degree of liquor atomization in recovery boiler burners and the absence of a well-defined liquor flame.

A major difference between the burner of the present invention and conventional oil burners is that a stable flame has to be formed with the use of a considerably lower amount of air or oxygen carrier.

As the exemplification below show, black liquor as a fuel is characterized by a relatively low calorific value and high water and ash contents.

Calorific value of the dry substance	13 GJ/ton dry substance (DS)
Elementary composition	$C_{29}H_{34}O_{20}Na_9S_2$
Dry solids content	65 %
Viscosity at 100°C	100 cSt.

The presence of sodium compounds in the black liquor and its inherently high oxygen content make it a very reactive fuel, which means, provided an adequate burner design is at hand that the carbon conversion already in the flame zone becomes high, in spite of the fact that the combustion is substoichiometric. The vortex burner described in the present invention provides high combustion efficiency and flame stability using black liquor as fuel in a relatively small reactor volume. The temperature in the reactor is above 700 °C, preferably around 900 °C. The molten inorganic chemicals, substantially sodium carbonate and sodium sulphide, are separated from the process gas in a quench dissolver connected to the reactor. The process gas is substantially composed of carbon monoxide, carbon dioxide, and hydrogen. The volume ratios of carbon monoxide, and carbon dioxide, in the process gas is allowed to vary between 0.8:1, and 1.8:1, and is controlled by i.a. the amount of oxygen added.

The flow pattern near the burner is influenced to a great extent by the level of vortex which can be controlled by e.g. adjusting the vortex blading. The radial flow rate of the oxygen containing gas is thereby markedly affected with a maintained axial flow rate. The main principle of the vortex burner is to recirculate a portion of the gases through an internal recirculation zone towards the liquor lance. This internal recirculation zone facilitates combustion and stabilizes the flame and the recirculated hot gases add energy for ignition of the liquor spray. The internal recirculation zone also serves as a depot for heat and reactive gas components.

The mixing of the liquor spray and the combustion air is supported by the turbulent shear surface between the recirculation zone and the discharged gas and liquor droplets.

An outer recirculation zone, however, of less importance for the stability of the flame is also developed. Its shape is influenced more by the geometry of the reactor than by the geometry of the burner.

The degree of atomization of the liquor is of great importance for obtaining a stable black liquor flame, the extension of the flame and high carbon conversion. The rheological properties of the black liquor are of significant importance to the degree of atomization which can be achieved in a given nozzle. The viscosity of the black liquor can be influenced by e.g. heating and/or the addition of additives and normally the black liquor is being heated to above 100 °C for use in the present invention. The viscosity of the black liquor at the moment of atomization should preferably be below 200 cSt.

Atomization of the black liquor can be further enhanced by flashing the liquor into the reactor in which case the liquor is preheated to a temperature above its boiling point at the operating pressure of the reactor.

Several types of atomizing nozzles are available but only a few varieties are suitable for atomizing cellulose spent liquors, such as black liquor, in the present invention.

"Twin-fluid" nozzles are most suitable for use in the present burner. A common feature of "twin-fluid" nozzles is that a relatively high gas flow rate is necessary for the supply of energy for the atomization. Another important feature of these nozzles is that the resulting size of the droplets decrease with increasing density of the atomizing gas. Depending on how the two fluid phases are brought together several mechanisms for forming droplets, such as shearing between ligaments, combination and formation of spheres of liquor droplets and high turbulence decomposition of the liquor spray can be anticipated.

<u>Description of the present invention</u>

The present invention describes a process for efficient substoichiometric combustion of cellulose spent liquors, using a burner-connected to a reactor, which invention is characterized in that at least half of the non-fuel related amount of oxygen which shall be added to the reactor to partially burn the black liquor added through the burner, is added to the reactor in the form of a hot oxygen containing gas which gas is added through a tubular channel arranged coaxially around a liquor lance arranged for the addition of said cellulose spent liquor, the weight ratio between the amount of oxygen of the oxygen containing gas added through the burner and of the added cellulose spent liquor solids being in the range of 0.1-0.7:1, preferably 0.15-0.5:1.

The attached drawing shows a vortex burner and two different "twin-fluid" nozzles, whereby

FIG. 1 schematically shows a vortex burner with its recirculation zone;

FIG. 2 shows an embodiment of a "twin-fluid" nozzle in an axial cross-section;

FIG. 3 shows a front view of the nozzle according to FIG. 2 seen along the line III-III of FIG. 2;

FIG. 4 shows a second embodiment of a "twin-fluid" nozzle in axial cross-section; and

FIG. 5 shows a front view of the nozzle according to FIG. 4 seen along the line V-V of FIG. 4.

FIG. 1 schematically shows a vortex burner 1 placed in a combustion chamber 22, and a vortex generator 24 arranged in a channel 23 for the purpose of adding air. The unbroken line in FIG. 1 shows the spatial distribution of the internal recirculation, the dotted line the internal recirculation zone, and the dashed line shows the limit of the return flow, i.e., the limit along which the recirculation turns (the axial zerovelocity line). The dashed line in the lower part of FIG. 1 also shows the limits of the outer recirculation. The vortex generator 24 is placed substantially behind the lower part of the liquor lance which means that the combustion air added outside the nozzle will circulate around the liquor lance before it meets and carries the atomized black liquor. By arranging the vortex generator adequately a flame having a toroidal vortex is developed, an important advantage for the stability of the flame and the course of the partial combustion.

FIGS. 2 and 3 show a twin-fluid nozzle where the liquor and gas are mixed and then forced under high pressure through several symmetrically arranged circular openings 3. These openings are the ends of so called Y-jet atomizing nozzles comprised of two tubes 4 and 5, the former in contact with an outer tube 6 on the liquor lance 1 for the purpose of adding black liquor and the later in contact with an inner concentric annular tube 7 for the purpose of adding atomizing gas, such as air or steam. The openings 3 diverge producing divergent atomized jets from the lower part 2 of the liquor lance 1. A hood 9 fitted to the body 10 of the liquor lance, holds the Y-jet atomizer 8 in place. The body 10 encloses the tubes 6 and 7, and the concentric annular tube 7. The black liquor is introduced into the liquor lance 1 through an inlet tube 20 and the air through another inlet tube 21.

FIGS. 4 and 5 show an embodiment of the burner gun having three concentric annular tubes 11, 12, and 13. Air is fed through the outer and the inner tubes 11, and 13, while black liquor is fed through the intermediate tube 12. The air is divided through the 18 symmetrically distributed holes 14, and 15 shown in the figures, while black liquor is forced through an annular gap 16. The holes 14 are hereby obliquely directed in one direction and the holes 15 obliquely directed in the opposite direction. The black liquor is fed through the gap 16 and meets a lip 17 forcing it in an inward direction. Now in the form of a film the black liquor is met by the air coming through the holes 16 and is atomized. This initial air-black liquor mixture is met by additional air outside the lip 17, creating a diverging jet of finely dispersed black liquor. The black liquor is added to the burner through an inlet tube 20 and the air through two inlet tubes 21.

Although air has been used in the description above the invention is not restricted to air but other gases, such as steam, nitrogen or oxygen enriched air can be used as atomizing gas.

When designing burners great attention has to be paid to the weight relationship between the air and fuel added.

The black liquor described herein is a fuel possessing unusual properties and thus a burner which shall provide a stable flame must be designed accordingly.

Different fuels contain different amounts of chemically bound oxygen. Bitumenous coal usually contains between 4-10 % of bound oxygen. Fuel oils contain less than 1 % of bound oxygen.

Black liquor dry solids contains about 35 % by weight of bound oxygen calculated on dry matter. This affects the design of burners for combustion of black liquor since only a small amount of oxygen, air or oxygen enriched air can be added to the burner to obtain the desired level of combustion.

The air/fuel ratio (by weight) for some fuels at stoichiometric combustion are exemplified below:

Antracite	Air/fuel	10-12:1
Ethyl alcohol	"-	9:1
Black liquor	"-	4-5:1
Diesel oil/heavy oil	"-	13-15:1

A burner for partial combustion of black liquor in accordance with the present invention is designed for an air/fuel solids ratio in the order of 0.5-3:1 which thus is considerably lower than ratios applied at stoichiometric as well as substoichiometric combustion of most other fuels. Since air consists of about 23 % by weight of oxygen the present black liquor burner is thus designed for an oxygen added/black liquor solids added ratio in the range of 0.1-0.7:1. To compensate for the low air/fuel ratios and to achieve reasonable gas velocities the air should be preheated to at least 100 °C, preferably to 300 °C and it should further be given vortex movement. Preheating of the air adds energy in close proximity of the burner, which further supports the stability of the flame. The larger part of the oxygen required for the partial combustion is added through a channel arranged coaxially around the liquor lance which channel in turn ends in the reactor in a divergent burner tile. Part of the oxygen required for the partial combustion can be added to the flame zone through the atomizing nozzle and optionally, another part can be added through secondary air gates in the upper part of the reactor.

Claims

1. Process for partial combustion of cellulose spent liquors using a burner connected to a reactor while adding an oxygen containing gas, **characterized** in that a temperature of more than 700 °C is maintained within the reactor and that at least half of the non-fuel related amount of oxygen which shall be added to the reactor to partially combust the cellulose spent liquor added through the burner, is added to the reactor as a hot oxygen containing gas added through a channel arranged coaxially around a liquor lance provided for the addition of said cellulose spent liquor, whereby the weight ratio between the oxygen of the oxygen containing gas and the cellulose spent liquor solids is in the range of 0.1-0.7:1.

2. Process according to claim 1, **characterized** in that the weight ratio between oxygen added in the oxygen containing gas and the cellulose spent liquor solids is 0.15-0.5:1.

3. Process according to claim 1, **characterized** in that the oxygen containing gas added through the coaxial channel has a vortex movement.

4. Process according to claim 1, **characterized** in that the oxygen containing gas added through the coaxial channel is forced to pass through vortex blading.

5. Process according to claim 1, **characterized** in that the stream of liquor in the liquor lance is brought into contact with a gas having a high velocity and a higher pressure than said cellulose spent liquor, increasing the velocity of the stream of liquor which forms a finely dispersed divergent spray of cellulose spent liquor exiting from the lower part of said liquor lance.

6. Process according to one or more of claims 1 to 5, **characterized** in that the cellulose spent liquor is discharged from the lower part of said liquor lance through at least three symmetrically arranged orifices or through a circular gap.

7. Process according to one or more of claims 1 to 6, **characterized** in that the oxygen containing gas is passed through a diverging nozzle arranged coaxially around the liquor lance, which nozzle ends in the reaction zone of said reactor.

8. Process according to one or more of claims 1 to 7, **characterized** in that the vortex blading is arranged substantially behind the atomizing nozzle of the liquor lance.

9. Process according to one or more of claims 1 to 8, **characterized** in that the oxygen containing gas is preheated to above 100 °C, preferably to above 300 °C.

10. Process according to one or more of claims 1 to 9, **characterized** in that the oxygen containing gas consists of air or oxygen enriched air.

11. Process according to one or more of claims 1 to 10, **characterized** in that the viscosity of the cellulose spent liquor prior to atomization has been decreased to less than 200 cSt, preferably to less than 100 cSt.

12. Process according to one or more of claims 1 to 11, **characterized** in that the cellulose spent liquor discharged into the reactor has a temperature above its boiling point at the prevailing reactor pressure.

Patentansprüche

1. Verfahren zur Teilverbrennung von Celluloseablaugen unter Einsatz eines an einen Reaktor angeschlossenen Brenners bei Zugabe eines sauerstoffhaltigen Gases, **dadurch gekennzeichnet,** daß eine Temperatur von über 700 °C innerhalb des Reaktors aufrechterhalten wird und daß mindestens die Hälfte der nicht brennstoffbezogenen Sauerstoffmenge, die dem Reaktor zugeführt wird, um die durch den Brenner zugeführte Celluloseablauge teilweise zu verbrennen, dem Reaktor als heißes sauerstoffhaltiges Gas zugeführt wird, das durch einen koaxial um die für die Einspeisung der genannten Celluloseablauge vorgesehene Laugenlanze angeordneten Kanal zugeführt wird, wodurch das Gewichtsverhältnis zwischen dem Sauerstoffanteil des sauerstoffhaltigen Gases und den Feststoffen in der Celluloseablauge im Bereich von 0,1-0,7:1 liegt.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet,** daß das Gewichtsverhältnis zwischen dem Sauerstoff, der in dem sauerstoffhaltigen Gas zugeführt wird, und den Feststoffen in der Celluloseablauge 0,15-0,5:1 beträgt.

3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet,** daß das über den koaxialen Kanal zugeführte sauerstoffhaltige Gas verwirbelt wird.

4. Verfahren nach Anspruch 1, **dadurch gekennzeichnet,** daß das über den koaxialen Kanal zugeführte sauerstoffhaltige Gas gezwungen wird, Verwirbelungsschaufeln zu durchströmen.

5. Verfahren nach Anspruch 1, **dadurch gekennzeichnet,** daß der Laugenstrom in der Laugenlanze mit einem Gas in Kontakt gebracht wird, das eine hohe Strömungsgeschwindigkeit und einen höheren Druck als die genannte Celluloseablauge aufweist, wodurch die Geschwindigkeit des Laugenstroms erhöht wird, der einen fein verteilten divergierenden Nebel aus Celluloseablauge bildet, der aus dem unteren Teil der genannten Laugenlanze austritt.

6. Verfahren nach einem oder mehreren der Ansprüche 1 bis 5, **dadurch gekennzeichnet,** daß die Celluloseablauge aus dem unteren Teil der genannten Laugenlanze durch mindestens drei symmetrisch angeordnete schmale Öffnungen oder durch einen ringförmigen Spalt austritt.

7. Verfahren nach einem oder mehreren der Ansprüche 1 bis 6, **dadurch gekennzeichnet,** daß das sauerstoffhaltige Gas durch eine divergierende Düse austritt, die koaxial um die Sauerstofflanze angeordnet ist, wobei diese Düse in der Reaktionszone des genannten Reaktors endet.

8. Verfahren nach einem oder mehreren der Ansprüche 1 bis 7, **dadurch gekennzeichnet,** daß die Verwirbelungsschaufeln im wesentlichen hinter der Zerstäubungsdüse der Laugenlanze angeordnet sind.

9. Verfahren nach einem oder mehreren der Ansprüche 1 bis 8, **dadurch gekennzeichnet,** daß das sauerstoffhaltige Gas auf über 100° C erwärmt wird, vorzugsweise auf über 300°C.

10. Verfahren nach einem oder mehreren der Ansprüche 1 bis 9, **dadurch gekennzeichnet,** daß das sauerstoffhaltige Gas aus Luft oder mit Sauerstoff angereicherter Luft besteht.

11. Verfahren nach einem oder mehreren der Ansprüche 1 bis 10**, dadurch gekennzeichnet,** daß die Viskosität der Celluloseablauge vor der Zerstäubung auf unter 200 cSt reduziert wurde, vorzugsweise auf unter 100 cSt.

12. Verfahren nach einem oder mehreren der Ansprüche 1 bis 11, **dadurch gekennzeichnet,** daß die Celluloseablauge, die in den Reaktor eingespeist wird, bei dem herrschenden Reaktordruck eine Temperatur über ihrem Siedepunkt hat.

Revendications

1. Procédé pour la combustion partielle de liqueurs de pulpes cellulosiques en utilisant un brûleur raccordé à un réacteur tout en ajoutant un gaz contenant de l'oxygène, caractérisé en ce que l'on maintient une température supérieure à 700°C à l'intérieur du réacteur et en ce qu'au moins la moitié de la quantité d'oxygène non apparentée au combustible qui doit être fournie au réacteur pour brûler partiellement la liqueur de pulpe cellulosique amenée par le brûleur, est ajoutée au réacteur sous forme de gaz contenant de l'oxygène chaud par un canal disposé coaxialement autour d'une lance à liqueur prévue pour l'addition de la liqueur de pulpe de cellulose, le rapport pondéral entre l'oxygène du gaz contenant de l'oxygène et des matières solides de liqueur de pulpe cellulosique se situant dans la plage de 0,1-0,7:1.

2. Procédé selon la revendication 1, caractérisé en ce que le rapport pondéral entre l'oxygène ajouté dans le gaz contenant de l'oxygène et les matières solides de liqueur de pulpe cellulosique est de 0,15-0,5:1.

3. Procédé selon la revendication 1, caractérisé en ce que le gaz contenant de l'oxygène ajouté par le canal coaxial présente un mouvement tourbillonnaire.

4. Procédé selon la revendication 1, caractérisé en ce que le gaz contenant de l'oxygène ajouté par le canal coaxial est amené de force-par l'ailettage tourbillonnaire.

5. Procédé selon la revendication 1, caractérisé en ce que le courant de liqueur dans la lance de liqueur est mis en contact avec un gaz ayant une vitesse élevée et une pression plus élevée que la liqueur de pulpe cellulosique, en augmentant la vitesse du courant de liqueur qui forme une pulvérisation divergente finement dispersée de liqueur de pulpe de cellulose sortant par la partie inférieure de la lance de liqueur.

6. Procédé selon une ou plusieurs des revendications 1 à 5, caractérisé en ce que la liqueur de pulpe cellulosique est déchargée par la partie inférieure de la lance de liqueur par au moins trois orifices disposés symétriquement ou par un espace libre circulaire.

7. Procédé selon une ou plusieurs des revendications 1 à 6, caractérisé en ce que le gaz contenant de l'oxygène est amené par une tuyère divergente disposée coaxialement autour de la lance de liqueur, laquelle tuyère aboutit dans la zone réactionnelle du réacteur.

8. Procédé selon une ou plusieurs des revendications 1 à 7, caractérisé en ce que l'ailettage tourbillonnaire est disposé sensiblement derrière la tuyère d'atomisation de la lance de liqueur.

9. Procédé selon une ou plusieurs des revendications 1 à 8, caractérisé en ce que le gaz contenant de l'oxygène est préchauffé jusqu'à une température supérieure à 100 °C, de préférence supérieure à 300 °C.

10. Procédé selon une ou plusieurs des revendications 1 à 9, caractérisé en ce que le gaz contenant de l'oxygène est constitué par de l'air ou par de l'air enrichi à l'oxygène.

11. Procédé selon une ou plusieurs des revendications 1 à 10, caractérisé en ce que la viscosité de la liqueur de pulpe cellulosique avant l'atomisation a été réduite à moins de 200 cSt, de préférence à moins de 100 cSt.

12. Procédé selon une ou plusieurs des revendications 1 à 11, caractérisé en ce que la liqueur de pulpe cellulosique déchargée dans le réacteur a une température supérieure à son point d'ébullition à la pression du réacteur existante.

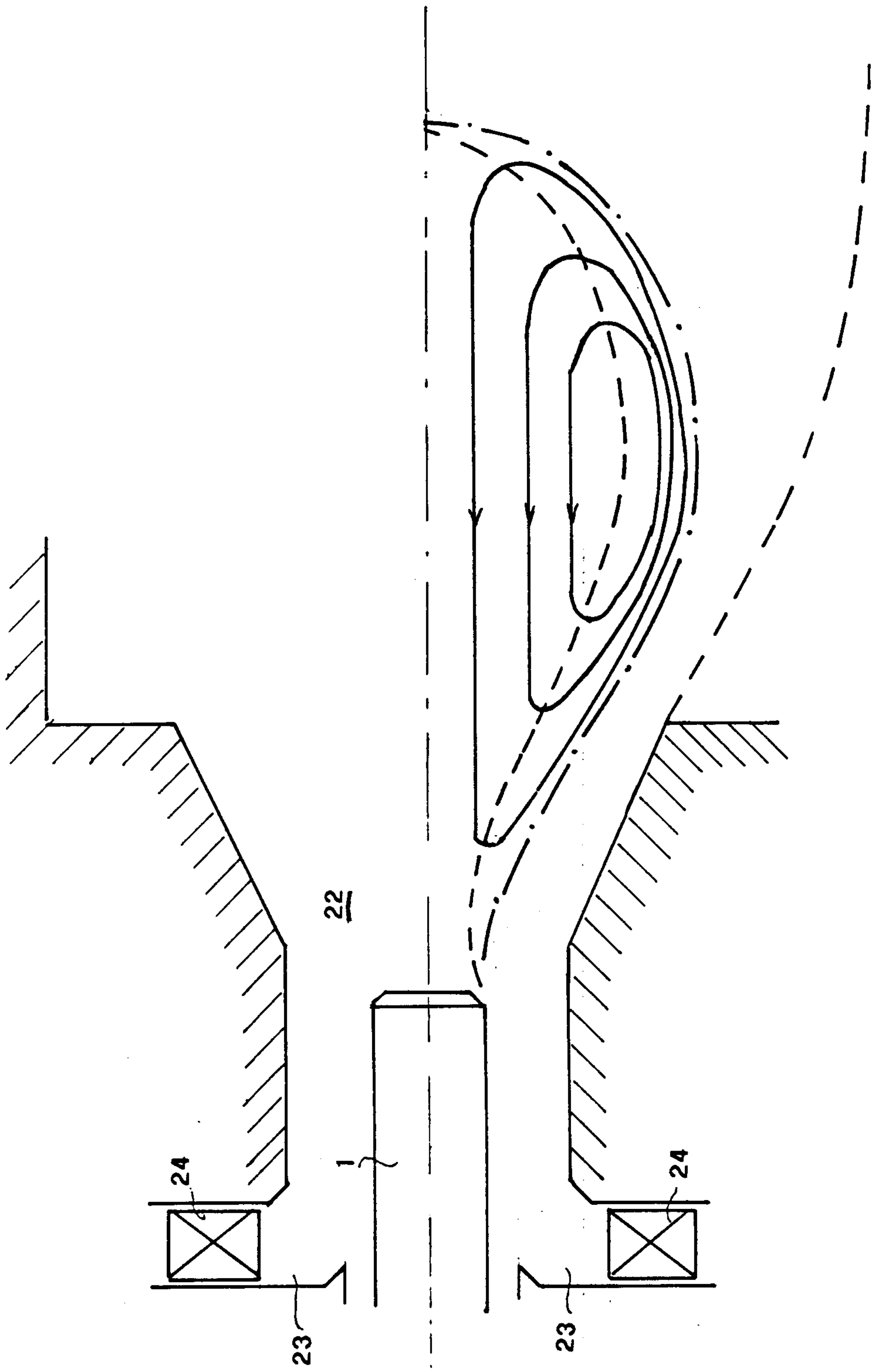

FIG. 1

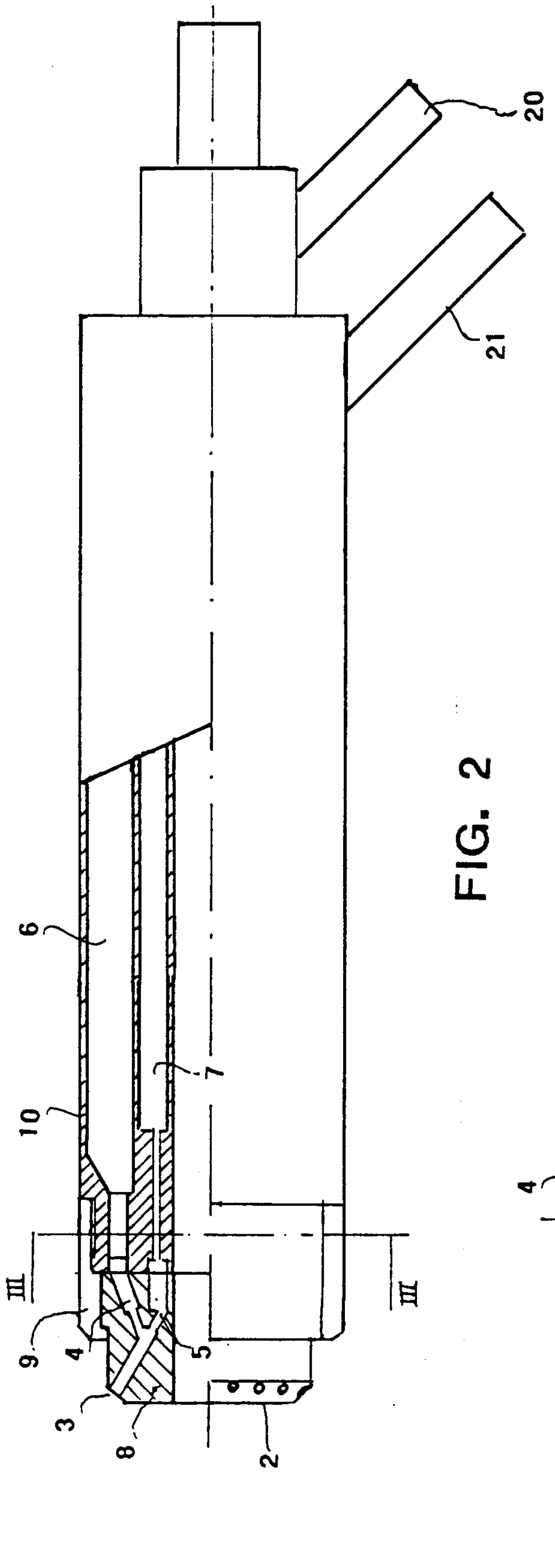

FIG. 2

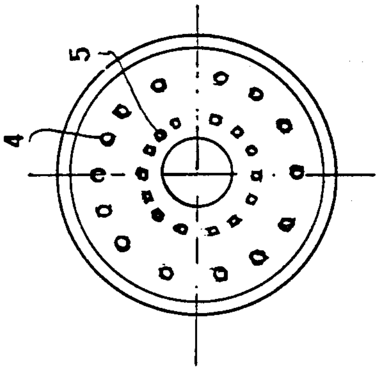

FIG. 3

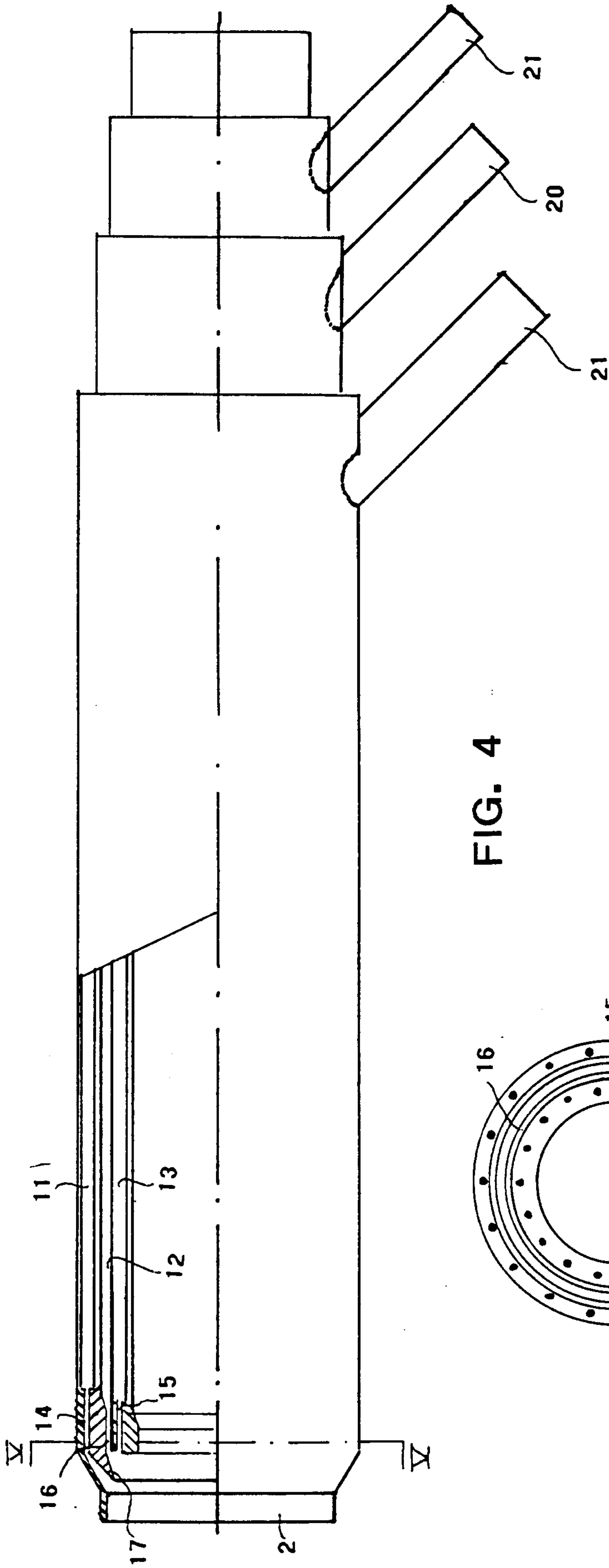

FIG. 4

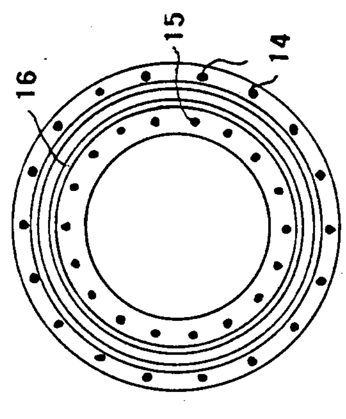

FIG. 5