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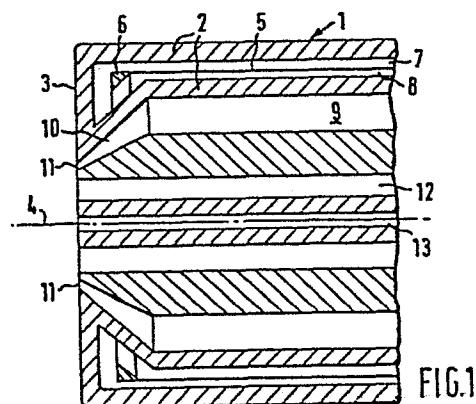
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(54) **Process and burner for the gasification of solid fuel.**

(57) **Process and burner for the gasification of a finely divided solid fuel.**

An annulus of finely divided solid fuel is supplied to a reactor space via an annular outlet channel (12) of a burner, the burner being further provided with a plurality of outlet passages (10) for supplying a plurality of high velocity oxygen jets into the reactor space in such a manner as to intersect the annulus of finely divided solid fuel.



PROCESS AND BURNER FOR THE GASIFICATION OF SOLID FUEL

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The present invention relates to a process for the gasification of a finely divided solid fuel and to a burner for carrying out such a process.

Gasification of a solid fuel may be defined as a process wherein solid fuel is partially combusted with a substoichiometric amount of pure oxygen or an oxygen containing gas, such as air, to form product gas consisting mainly of carbon monoxide and hydrogen. Depending on the composition of the combustion medium the product gas further contains other substances which may be useful or may be considered as pollutants.

Although the present invention will primarily be described with reference to pulverized coal, it should be noted that the burner and process according to the invention are also suitable for other types of solid fuels which can be gasified, such as lignite, wood, bitumen, soot and petroleum coke.

According to a well known gasification process solid fuel in a finely divided state is passed with a carrier gas to a reactor-zone via a burner, while the combustion medium is either added to the solid fuel flow inside the burner or is separately introduced into said reactorzone. Great care must be taken that the reactants are effectively mixed with one another. If the reactants are not brought into intimate contact with each other, the oxygen and solid fuel flow will follow at least partially independent trajectories inside the reactor. Since the reactor zone is filled with mainly hot carbon monoxide and hydrogen, the oxygen will rapidly react with these gases instead of with the solid fuel. The so formed very hot combustion products carbon dioxide and steam will also follow independent trajectories having poor contact with the relatively cold solid fuel flow. This behaviour of the oxygen will result in local hot spots in the reactor, thereby possibly causing damage to the reactor refractory lining and increased heat fluxes to the burner(s) applied.

Sufficient mixing of the solid fuel and the oxygen can be attained by adding the oxygen to the solid fuel flow in the burner itself. A disadvantage of this method consists, however, therein that - especially at high pressure gasification - the design and operation of the burner are highly critical. The reason for this is that the time elapsing between the moment of mixing and the moment the fuel/oxygen mixture enters into the reactor zone should be invariably shorter than the combustion induction time of the mixture. Moreover, the velocity of the mixture inside the burner should be higher than the flame propagation velocity in order to avoid flashback. However, the combustion induction time shortens and the flame propagation velocity increases at a rise in gasification pressure. Further, if the burner is operated at a low fuel load or, in other words, if the velocity of the fuel/oxygen mixture in the burner is low, the combustion induction time or flashback condition might easily be reached in the burner itself, resulting in overheating and possibly severe damage to the burner.

The above-mentioned problem of the premature combustion in the burner itself will not occur if the fuel and oxygen are mixed outside the burner in the reactor space itself. In this case special measures are, however, to be taken to ensure a sufficient mixing necessary for an effective gasification of the fuel as discussed in the above. To promote an intimate mixing of fuel and oxygen it has already been proposed to introduce the oxygen as high velocity jets into the fuel flow. Applicant's copending British patent application No. 8229811 relates to such a system for gasification of solid fuel in which a core of solid fuel is introduced into a reactor space and oxygen in the form of high velocity jets are directed towards the core of solid fuel for breaking up the solid fuel flow so that all fuel particles can be contacted with oxygen for the purpose of gasification. This already proposed method for contacting the solid fuel with oxygen is attractive if the core of solid fuel can be kept rather small or, in other words, if a rather low capacity gasification process

is aimed at. Problems may occur when high throughputs of solid fuel are to be processed. In the latter case the solid fuel should be supplied as a relatively thick core into the reactor space. Increase of the thickness of the core, however, has an adverse
5 influence on the possibility of breaking up the solid fuel flow. The oxygen should then be supplied to the solid fuel flow with extremely high velocities necessary for a sufficient penetration into the solid fuel. Such high velocity jets may easily cause
10 suction of the already formed reactor gases along the burnerfront with the risk of overheating of the latter. In the above-mentioned previous patent application it is therefore proposed to surround the high velocity oxygen jets with shields of relatively low velocity steam for suppressing suction of reactor gases.

An object of the present invention is to provide a process
15 for the gasification of in particular high quantities of solid fuel wherein the solid fuel flow can be properly broken up by oxygen jets having a relatively moderate velocity.

The process for the gasification of a finely divided solid fuel thereto comprises according to the invention supplying finely
20 divided solid fuel as an annulus into a reactor space and introducing oxygen or an oxygen containing gas into said reactor space, allowing the oxygen or oxygen containing gas to react with the finely divided solid fuel for gasification of the latter, wherein at least part of the oxygen or oxygen containing gas is introduced
25 into the reactor space as a plurality of high velocity jets arranged to intersect the annulus of finely divided solid fuel.

Since in the above process the solid fuel is supplied to the reactor space as an annulus, the thickness of the solid fuel flow can be kept rather moderate even at high fuel throughputs. The
30 solid fuel can be easily penetrated by the oxygen jets for a proper breaking up of the fuel flow.

The oxygen jets are preferably uniformly distributed with respect to the annular solid fuel flow, to ensure a substantially uniform breaking up to the solid fuel flow. The number of oxygen

jets which should be applied depends, among other things, on the diameter of the annulus of solid fuel, on the width of the annulus and on the behaviour of the solid fuel itself. If the solid fuel flow is relatively compact, a relatively large amount of oxygen jets will be required for attaining a proper breaking up of the solid fuel flow. Care should, however, be taken that the oxygen jets are sufficiently spaced apart from one another to avoid reduction of the oxygen jet momenta due to interference between the oxygen jets.

10 In a suitable embodiment of the invention the oxygen jets are arranged to intersect the annulus of finely divided solid fuel from the outside. For substantially eliminating the risk of escape of non-converted solids, it may be advantageous to arrange the oxygen jets in such a manner that they form a substantially closed shield around the annular solid fuel flow without, however, interfering with one another. It is also possible to reach the above objective by applying shielding means separate from the oxygen jets for breaking up the solid fuel flow. It is preferred to apply a low velocity flow of oxygen or oxygen containing gas for forming said shield around the arrangement of solid fuel flow and oxygen jets for break-up.

25 In a preferred gasification process according to the invention, combustion medium is not only supplied via the high velocity jets intersecting the annular solid fuel flow from the outside but also via a further supply source substantially centrally arranged inside the annular solid fuel flow. This further combustion medium, formed by oxygen or an oxygen-containing gas, serves apart from the combustion aspect a plurality of purposes. This central gas flow will keep the flame formed after ignition of the combustible mixture of solid fuel and oxygen, away from the burner front thereby reducing the risk of overheating of the burner. It further serves as a support of the annular solid fuel flow preventing collapse of the fuel flow upon exposure to the oxygen jets.

In a further suitable embodiment of the invention the oxygen jets are grouped in pairs, wherein the jets of each pair are arranged at opposite sides inside and outside of the annular solid fuel flow in such a manner that these jets intersect one another substantially in the annulus of solid fuel. This arrangement of the oxygen jets is particularly suitable for high capacity operation in which the annulus of solid fuel should necessarily have a rather large width. The groupwise positioning of the oxygen jets ensures that the solid particles remain in the annulus of fuel and are not pushed away from the desired trajectory by the oxygen jets operating from the inner side of the solid fuel annulus. The last-mentioned process according to the invention may be further optimized by the supply of low velocity gas in the annulus, preferably in the centre, for further supporting the annulus of solid fuel. As already indicated in the above with reference to the process in which the oxygen jets are all located outside the annulus, the low velocity gas preferably consists of oxygen or an oxygen containing gas, serving not only as a support for the fuel annulus but also as further combustion medium completing the amount of oxygen required for a proper gasification of the fuel.

The groups of oxygen jets are preferably substantially uniformly distributed relative to the annulus of finely divided solid fuel in order to obtain a substantially homogeneous mixture of solid fuel and oxygen, resulting in a stable operation and high quality gasification products. In a suitable embodiment of the latter process the annular solid fuel flow and the groupwise arranged oxygen jets are surrounded by a shield of low velocity gas, preferably oxygen or oxygen containing gas. The velocity of the shielding gas flow is suitably chosen in the range of about 5 to 20 m/sec.

As already mentioned in the above, the important feature of the invention consists herein that it makes it possible to attain high throughputs of solid fuel at acceptable velocities of the oxygen jets without impairment of the quality of the gasification.

The velocities of the oxygen jets may be chosen in the usual range of about 60 to 100 m/sec. These velocities can be easily reached in the available burners without damage of the burnerwalls.

5 The invention further relates to a burner for the gasification of a finely divided solid fuel, which burner comprises an annular outlet channel for finely divided solid fuel and a plurality of outlet passages for oxygen or an oxygen containing gas, the axes of said outlet passages being arranged to intersect the extension of the annular outlet channel in downstream direction.

10 The oxygen outlet ports are preferably substantially uniformly distributed relative to the annular outlet channel.

In a first suitable embodiment of the above burner the outlet passages are arranged around the annular outlet channel. In a further suitable variant, the outlet passages are grouped in
15 pairs, the outlet passages of each pair being arranged at opposite sides inside and outside of the annular outlet channel and having their axes arranged to intersect one another substantially in the extension of the annular outlet channel.

For supplying oxygen or oxygen containing gas inside the
20 annular solid fuel flow issuing from the annular outlet channel, the burner may optionally be provided with a central oxygen outlet channel being substantially coaxially arranged in the annular outlet channel.

The burner according to the invention may suitably be further
25 provided with an annular outlet channel substantially coaxially surrounding the annular outlet channel for supplying a shield of low velocity oxygen or oxygen containing gas around the solid fuel and oxygen jets during operation of the burner.

The invention will now be further described by way of example
30 only with reference to the accompanying drawings, in which

Figure 1 shows a longitudinal section of the front part of a first burner according to the invention;

Figure 2 shows the front view of the burner depicted in Figure 1;

Figure 3 shows a longitudinal section of the front part of a second burner according to the invention; and

Figure 4 shows the front view of the burner depicted in Figure 3.

5 It should be noted that identical elements shown in the drawings have been indicated with the same reference numeral. It is further noted that the invention is by no means limited to the description based on these drawings.

Referring to Figures 1 and 2, the front part of a burner,
10 generally indicated with reference numeral 1, for the gasification of a finely divided solid fuel, such as pulverized coal, is shown which burner comprises a cylindrical hollow wall member 2 with an enlarged end part forming a front face 3 which extends substantially normal to the longitudinal axis 4 of the burner. The interior
15 of the hollow wall member 2 is provided with a substantially concentric partition wall 5 having an enlarged endpart 6 arranged near the burner front face 3. The partition wall 5 divides the interior of the hollow wall member 2 into passages 7 and 8 for the circulation of a cooling fluid therethrough. The hollow wall
20 member 2 surrounds an annular oxygen supply channel 9, at the downstream end provided with a plurality of inwardly inclined oxygen outlet passages 10 with outlet ports 11 in the burner front face 3. As clearly shown in Figure 2 the oxygen outlet ports are uniformly distributed over a circle with the centre on the longitudinal burner axis 4.
25

The annular oxygen supply channel 9 surrounds a smaller annular outlet channel 12 intended for the supply of solid fuel. Finally, a substantially cylindrical channel 13 for the supply of oxygen is arranged in the centre of the burner. The oxygen channels 9 and 13 may be supplied with oxygen via a common source. For
30 the control of the burner operation, it is advantageous to connect the oxygen channels 9 and 13 with separate supply sources.

The operation of the burner for the gasification of for example pulverized coal is as follows. Pulverized coal suspended in

a carrier fluid is passed through the annular outlet channel 12 into a reactor space downstream of the burner outlet. Simultaneously the blast, mainly containing oxygen, is passed through the annular oxygen supply channel 9 and the outlet passages 10 and enters into said reactor space as a plurality of high velocity jets issuing from the oxygen outlet ports 11. The radial components of the momenta of the high velocity oxygen jets, directed towards the annular coal flow, cause a breaking up of the coal flow and an intensive mixing of the coal with the oxygen. At a given inclination of the oxygen outlet passages 10, the velocity of the oxygen jets should be chosen such that the oxygen can penetrate into the coal flow without substantially re-emerging therefrom. Suitable velocities of the oxygen jets are for example in the range of between 60 and 90 m/sec. The annular coal flow is at its inner side supported by oxygen supplied via the central oxygen channel 13. This central oxygen flow forms moreover an additional combustion medium source for the gasification of the coal. In order to obviate constriction and thus compaction of the coal annulus at the location where the high velocity oxygen jets penetrate into the coal flow. The annular coal flow preferably has a rather moderate velocity.

In the embodiment of the invention shown in the Figures 3 and 4, the burner is not only provided with oxygen outlet passages having outlet ports around the annular coal channel 12 but also with oxygen outlet passages 20 having outlet ports 21 arranged within said channel 12. The outlet passages 20 are outwardly inclined towards the annular coal channel 12 and are arranged opposite to the outlet passages 10, so that during operation of the burner the oxygen jets from opposite oxygen outlet ports meet one another in the annular coal flow. The oxygen outlet passages 20 are connected to an annular oxygen supply channel 22 surrounded by the annular outlet channel 12.

During operation of the burner shown in Figures 3 and 4, the oxygen jets issuing from the outlet ports 11 and 21 will attack

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the flow from the annular channel 12 from both sides, causing a breaking up of even relatively thick solid fuel flows. As the inner ports are arranged opposite to the outer oxygen outlet ports, escape of solid particles due to the energy of the inner
5 oxygen jets is prevented by the outer oxygen jets.

C L A I M S

1. Process for the gasification of a finely divided solid fuel, comprising supplying finely divided solid fuel as an annulus into a reactor space and introducing oxygen or an oxygen containing gas into said reactor space, allowing the oxygen or oxygen
5 containing gas to react with the finely divided solid fuel for gasification of the latter, wherein at least part of the oxygen or oxygen containing gas is introduced into the reactor space as a plurality of high velocity jets arranged to intersect the annulus of finely divided solid fuel.
- 10 2. Process as claimed in claim 1, in which the high velocity jets are uniformly distributed relative to the annulus of finely divided solid fuel.
3. Process as claimed in claim 1 or 2, in which the high velocity jets are arranged to intersect the annulus of finely divided
15 solid fuel from the outside.
4. Process as claimed in claim 1 or 2, in which the high velocity jets are grouped in pairs, the jets of each pair being arranged at opposite sides inside and outside of the annulus of finely divided solid fuel and positioned as to intersect one another in said annulus.
20
5. Process as claimed in any one of the claims 1-4, in which part of the oxygen or oxygen containing gas is supplied to the reactor space as a core centrally arranged within the annulus of finely divided solid fuel.
- 25 6. Process as claimed in any one of the claims 1-5, in which part of the oxygen or oxygen containing gas is supplied to the reactor space as an annulus with low velocity surrounding the arrangement of finely divided solid fuel annulus and high velocity oxygen jets.

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7. Burner for the gasification of a finely divided solid fuel, comprising an annular outlet channel (12) for finely divided solid fuel and a plurality of outlet passages (10) for oxygen or an oxygen containing gas, the axes of said outlet passages being arranged
5 to intersect the extension of the annular outlet channel in downstream direction.

8. Burner as claimed in claim 7, in which the outlet passages for oxygen or oxygen containing gas are uniformly distributed with respect to the annular outlet channel.

10 9. Burner as claimed in claim 7 or 8, in which the outlet passages are arranged around the annular outlet channel.

10. Burner as claimed in claim 7 or 8, in which the outlet passages are grouped in pairs, the outlet passages of each group being arranged at opposite sides inside and outside of the annular
15 outlet channel and having their axes arranged to intersect one another substantially in the extension of the annular outlet channel.

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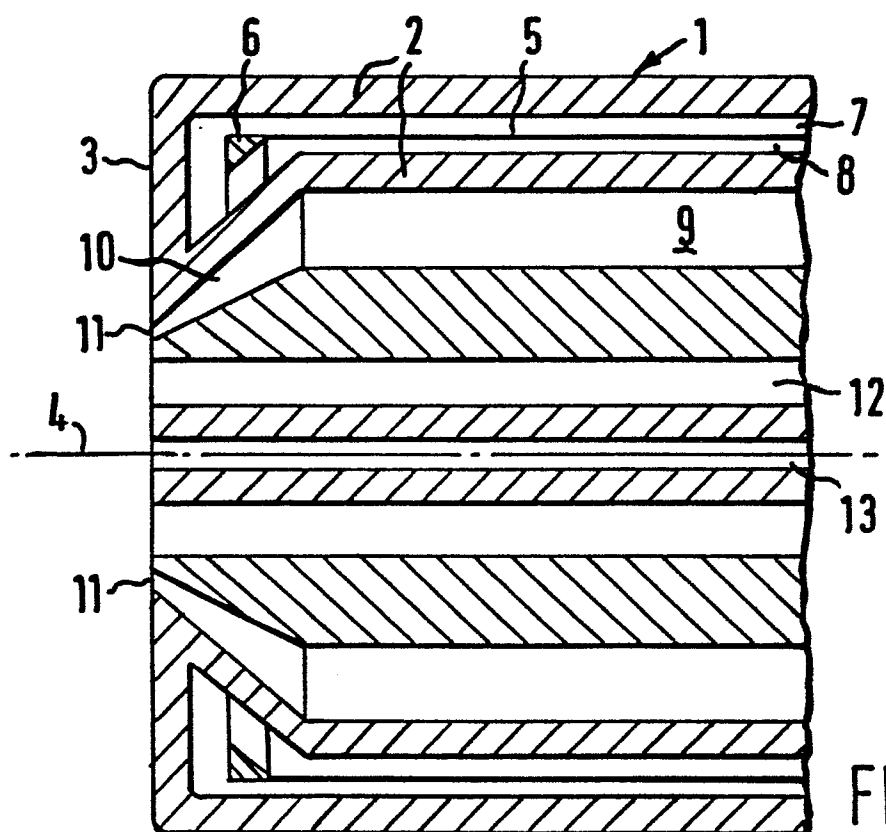


FIG. 1

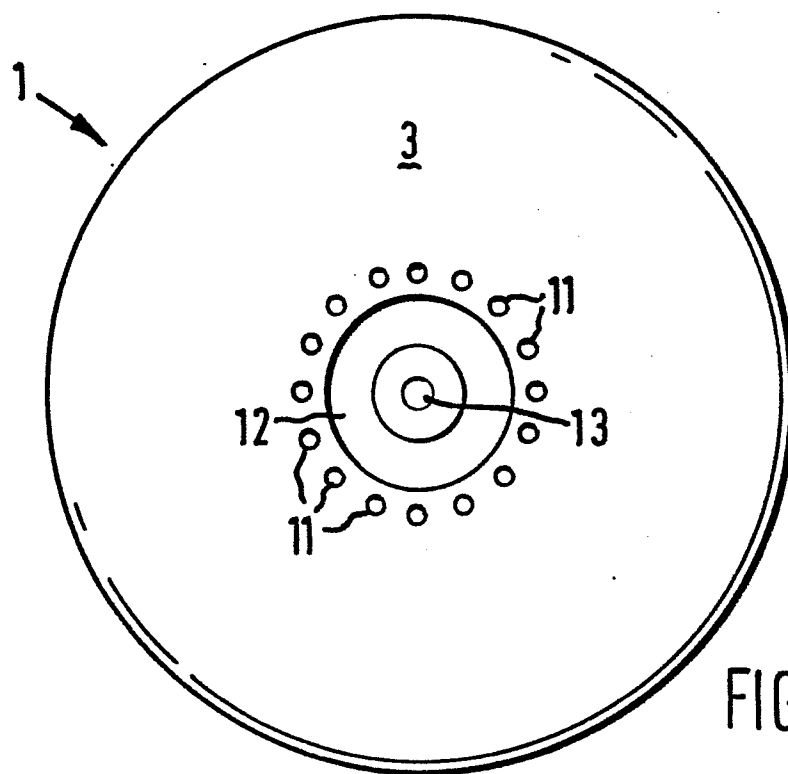


FIG. 2

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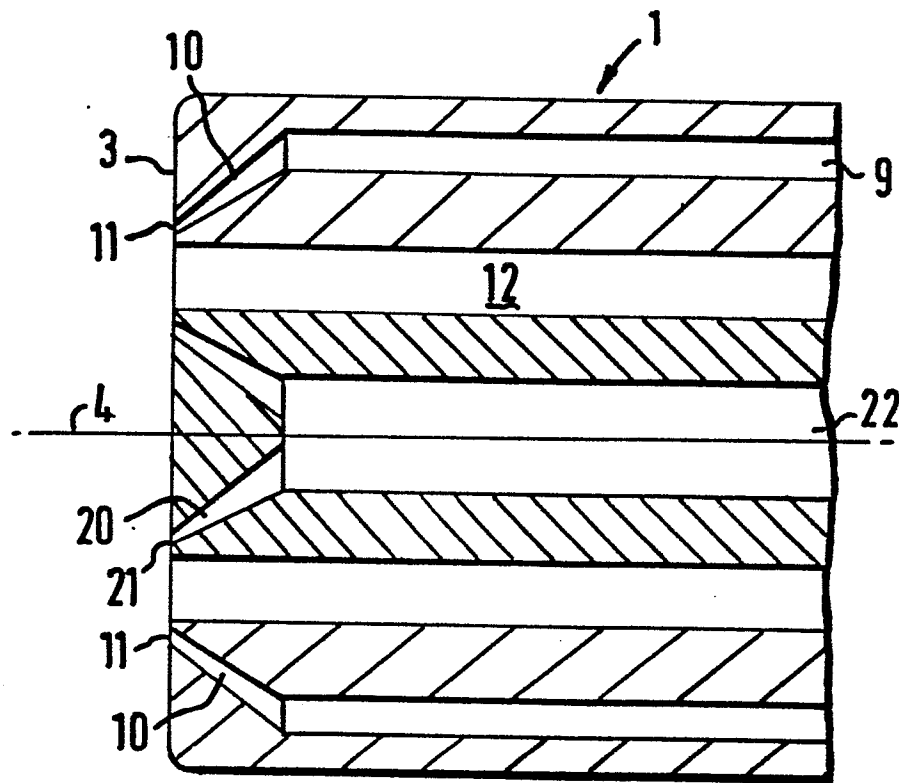


FIG. 3

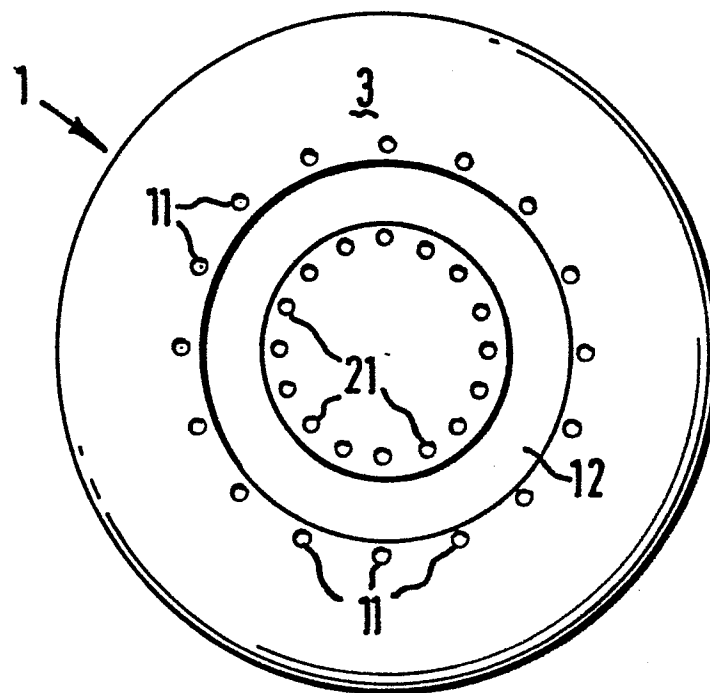


FIG. 4