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SINGLEPHASE OR POLYPHASE ELECTRIC ARC DEVICE FOR PRODUCING GAS CURRENTS HAVING A HIGH ENERGY DENSITY

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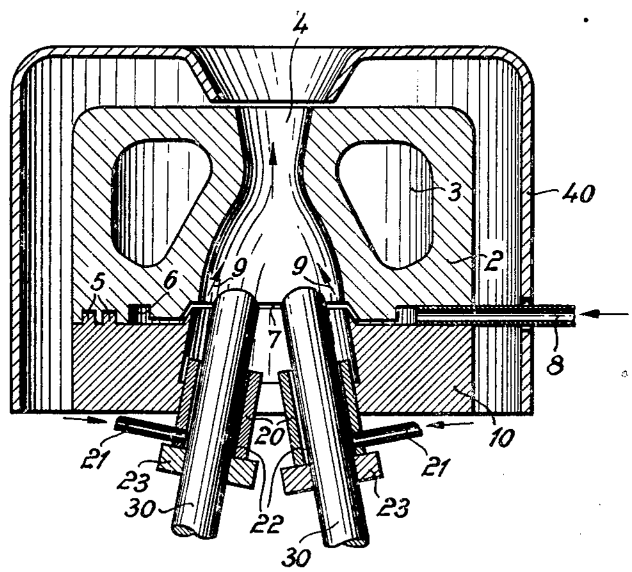

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SINGLEPHASE OR POLYPHASE ELECTRIC ARC DEVICE FOR PRODUCING GAS CURRENTS HAVING A HIGH ENERGY DENSITY

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4 Claims. (Cl. 219—121)

The present invention relates to a device for producing gas currents having a high energy density and high temperatures by heating gases in a single phase or polyphase electric arc. The word "gases" is here intended also to include vapors, for example steam or hydrocarbon vapors.

Various processes have been proposed for heating gases in an electric arc. According to these proposals, high-voltage arcs and heavy-current arcs are used. Of the heavy-current arrangements, those working on direct current have been preferred because it has not been possible to overcome the difficulty of producing a uniformly burning high power electric arc with alternating or more particularly with three-phase current, using metal electrodes. However, direct current equipment has disadvantages when compared with alternating current equipment in that it is in general more expensive as regards prime cost, and has higher operating losses because it cannot be regulated as easily.

In order that sufficient thermal energy may be obtained, the power consumption of the electric arc must be sufficiently high. When the current intensity is to be increased, it must be taken into consideration that, with a view to keeping the electrodes cool, the current density in the electrode cross-section must not exceed certain values. On the other hand, narrow limits are set for the dimension of the electrode cross-section for reasons concerned with the construction and thermal efficiency of the equipment.

If it be desired to use a high arc voltage, the distance between the electrodes must be relatively great even for normal operation. This requires a sufficient distance between the electrodes and the wall of the arc chamber to prevent flashover to the said wall. This measure, in its turn, results in a greater volume of the arc chamber, whereby the energy density which is of importance in these processes for any given power, is decreased.

The present invention provides an arrangement which enables the above-mentioned disadvantages to be overcome and ensures quiet burning of a heavy-current arc between graphite electrodes supplied with single phase or polyphase current, even if great amounts of gas are introduced into the arc chamber which simultaneously serves as a reaction chamber, the energy density being of the order of 10^9 kcal./m.^{3}h.

According to the present invention, there is provided a device for the production of gas currents having a high energy density by heating gases in a singlephase or polyphase electric arc, in which at least two electrodes project into the reaction zone of an arc chamber, each of the electrodes being surrounded, in the region where it enters the combustion chamber, by an annular gas supply channel so arranged that each electrode becomes uniformly enveloped by a branch current of the gas which is introduced into the reaction chamber and subsequently passes through the electric arc where it is heated.

According to a further feature of the present invention,

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the arc chamber casing is provided with an annular slot associated with a short inlet pipe through which an additional gas current can be introduced into the reaction zone to mix with the gas currents which have been heated in the electric arc.

The electrodes are advantageously disposed at acute angles or almost parallel to one another, the branch currents of gas flowing at acute angles or almost parallel to one another in the reaction zone before uniting tangentially.

Devices for controlling the speed at which the gas passes through the arc may be fitted. The current intensity: voltage ratio of the arc can then be regulated by means of the velocity of the gas.

In polyphase arrangements the supply of the branch currents of gas entering along the electrodes may be periodically interrupted by means of a shut-off device working on the operating frequency so that only those electrodes which are producing the arc are enveloped by the gas to be heated.

The walls of the arc chamber may be lined with a material reflecting light rays and heat rays. The lining may furthermore be porous, thus allowing a current of gas or of liquid which has been introduced into and flows in the space between said lining and the wall to diffuse into the arc chamber and to cover the lining of the latter with a mist of gas or liquid. In this manner transmission by convection of too great an amount of heat to the walls of the arc chamber is prevented.

The annular slots and annular channels through which the gases enter the arc chamber may be provided with diffusers of burned or sintered porous material. The position of the annular slot in the arc chamber casing is variable with respect to the position of the electric arc. The direction in which the gases leave the annular slot may also be variable.

The gas to be heated is subdivided into several equal branch currents each of which is conducted to its alloted electrode. Upon entering the arc chamber, each branch current envelops its respective electrode like a jacket, thus cooling it at the same time.

It has been found that the current intensity:voltage ratio of the arc can be varied by adjusting the rate at which the gas enters the arc chamber. With the preferred construction of the arrangement, the flowing gas entrains the charge carriers of the arc for a certain distance, thus increasing the length of the arc and thereby its resistance. In this manner, an elevated voltage may be applied in spite of a short distance between the electrodes. This, however, means an increased power input and, since a shorter distance between the electrodes and a smaller electrode cross-section permit the use of a smaller arc chamber, the energy density is also increased. The phenomenon is especially pronounced if the electrodes are almost parallel to one another.

It may be advantageous to proceed in a manner such that a portion of the starting gas volume, or another gas serving as a reactant, instead of being heated in the electric arc, is united in the cold or preheated state in the arc chamber with the branch currents of gas which have been heated in the electric arc. In which zone of the arc chamber this additive gas is advantageously supplied depends on the conditions in any given case. It is therefore of advantage that the position of the annular slot through which the additive gas is introduced into the arc chamber be variable with respect to the position of the arc.

This introduction of an additive gas according to the invention considerably reduces the danger of flashover to the walls of the arc chamber and simultaneously reduces heat transfer to the said walls by convection.

To diminish the heat losses due to the absorption of radiant energy by the walls, the arc chamber is made of or lined with a material having a high reflecting power. In this connection the shape and the surface finish of the walls of the arc chamber, which is to serve also as a reaction chamber, are also important since it is here a question of diminishing as far as possible the heat transfer between the hot flowing gas and the walls of the reaction chamber. The flow of gas should therefore be as laminar as possible, except for a thin boundary layer. A smooth surface of the walls furthermore impedes any deposition of reaction products such as soot.

A device according to the invention will now be particularly described by way of example with reference to the accompanying drawing, which is in sectional elevation.

The casing of an arc chamber is formed by an axially symmetrical body 2 and a flange 10 carrying the electrodes. The body 2 is provided with an annular cooling channel 3 for a cooling agent. The arc combustion space 4 serving as the reaction zone is disposed concentrically in the arc chamber casing 2, 10. The flange 10 carrying the electrodes is disposed beneath the body 2 and is connected with the latter in a gastight manner by means of recesses provided with packing rings and projections 5. An annular channel concentrically surrounding the arc combustion space is represented at 6. If desired, a gas can be introduced into the said annular channel 6 through a short inlet pipe 8. The gas then enters the reaction zone 4, as indicated by the arrows 9, through an annular slot 7 provided between the body 2 and the flange 10. The flange 10 which is likewise axially symmetrical is conncentrically fixed to the body 2 and is provided with bore-holes for inlet conduit nipples 20 which support the electrodes 30. The number of inlet nipples 20 and electrodes 30 depends on the number of phases of the power equipment. The inlet nipples 20 are provided with axial channels, for example annular channels 22, into which the gas to be heated is introduced by way of short pipes 21. This gas flows through the annular channels 22 into the reaction zone 4, enveloping the electrodes 30 like a jacket, and passes through the electric arc burning between the electrodes, thus being heated. If desired, another gas serving as a reactant may simultaneously be introduced through the short inlet pipe 8 by way of the annular channel 6 and the annular slot 7 into the hottest area of the reaction zone 4.

The inlet nipples 20 must be electrically insulated with respect to one another and with respect to the flange 10. For this purpose layers of aluminum oxide produced by anodic oxidation are used with special advantage.

In special cases it may be desired to proceed with a more diffused gas current having a low gas velocity. This can be achieved by inserting a ring of a sintered porous material serving as a diffuser in the annular slot 7 or in the annular channels 22.

The annular channels 22 are sealed in a gastight manner against the exterior by rings 23 provided with packing members not shown in the drawing.

The electrodes 30 are automatically advanced in known manner as they are used up.

Special measures are applied for keeping the amount of heat lost as small as possible and to return a fairly large portion thereof to the process.

It is of advantage to impart a high reflecting power to the walls bounding the reaction zone 4 by choosing an appropriate material of suitable high-class surface finish. A suitable surface finish also impedes the deposition of reaction products such as soot. Furthermore, in the interior of the body 2 a cooling channel 3 is disposed through which a suitable cooling agent may be passed. Under appropriate conditions, for example if the gas velocity is sufficiently high and/or the thermal conductivity of the gas in question is sufficiently high, one of the gaseous reactants to be introduced into the reaction zone 4 may serve as a cooling agent. In this case, the said reactant travels, prior to its entrance into the reaction chamber, through the cooling channel 3 thus cooling the body 2 whereby it is itself simultaneously preheated.

In the case particularly of equipment having a relatively small power, additional insulation against loss of heat and thus a reduction of the heating energy which must be produced can be obtained according to the known principle of the multiple reflection of radiation, with the aid of a cowling 40 surrounding the device of the invention at a certain distance, the inside wall of the cowling reflecting radiation.

In special cases it may be of advantage that the branch currents of gas which are introduced into the reaction zone 4 by being conducted along the electrodes 30 through the annular channels 22 do not enter the reaction chamber steadily, but are periodically interrupted in cyclic alternation in a manner such that each branch current of gas is cut off as long as the electrode allotted to it is without electric current. This may be achieved by mean of a shut-off device which is simultaneously operated with the operating frequency.

Gas currents which have been heated to high temperatures in this manner may be used for various purposes, if desired with the use of a suitably profiled expanding nozzle. For example, the thermal energy of the gas current may be used directly for the cutting, welding or melting of substances, or for the thermal splitting up of compounds introduced in gaseous form. The thermal energy may also be converted to kinetic energy to be used, for example, for driving jet power plants. It is also possible to use the energy latent in the thermal splitting up of gas molecules into atoms as recombination heat for carrying out endothermic chemical reactions.

The apparatus shown in the accompanying drawing may be used in any position in space, for example in a position inverted with respect to that shown in the drawing in which case the electrodes and the gas outlet point downwards.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. A device for producing a gas current of high energy density by heating gases in an electrical arc which device comprises an arc chamber, a reaction zone in said chamber, at least two electrodes projecting into the reaction zone of the arc chamber, a gas supply conduit surrounding each electrode in the regions where said electrodes enter the reaction chamber, each electrode being uniformly enveloped by a current of the gas issuing from the gas supply conduits which gas passes into the reaction chamber and through an electrical arc formed by the electrodes to be heated, and an annular cooling channel extending through the arc chamber through which channel a cooling agent is passed.

2. Device as claimed in claim 1, wherein the electrodes are disposed at acute angles to one another, the branch currents of gas flowing at acute angles to one another in the reaction chamber before uniting tangentially.

3. A device for producing a gas current of high energy density by heating gases in an electrical arc which device comprises an arc chamber, a reaction zone in said chamber, at least two electrodes projecting into the reaction zone of the arc chamber, a gas supply conduit surrounding each electrode in the regions where said electrodes enter the reaction chamber, each electrode being uniformly enveloped by a current of gas issuing from the gas supply conduits which gas passes into the reaction chamber and through an electrical arc formed by the electrodes to be heated, an annular gas feed channel disposed in the arc chamber, and communicat-

ing with the reaction zone, and means connecting with the feed channel and extending externally of the arc chamber for introducing an additional gas current into the gas feed channel and reaction chamber to be mixed with the gas currents entering the reaction chamber which initiates from the annular gas supply conduits surrounding the electrodes.

4. A device as claimed in claim 3 wherein the electrodes are disposed at acute angles to one another whereby the branch currents of gas flow at acute angles to one

another in the reaction chamber before uniting tangentially.

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