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[54] **COMPOSITE WALLS FOR MHD-GENERATOR DUCTS**

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[52] **U.S. Cl.** **310/11**, 313/311

[51] **Int. Cl.** **H02n 4/02**

[58] **Field of Search** 310/11; 313/311, 312, 346

[56] **References Cited**

UNITED STATES PATENTS

3,280,349	10/1966	Brenner et al.	310/11
3,432,715	3/1969	Yerouchalmi	313/346

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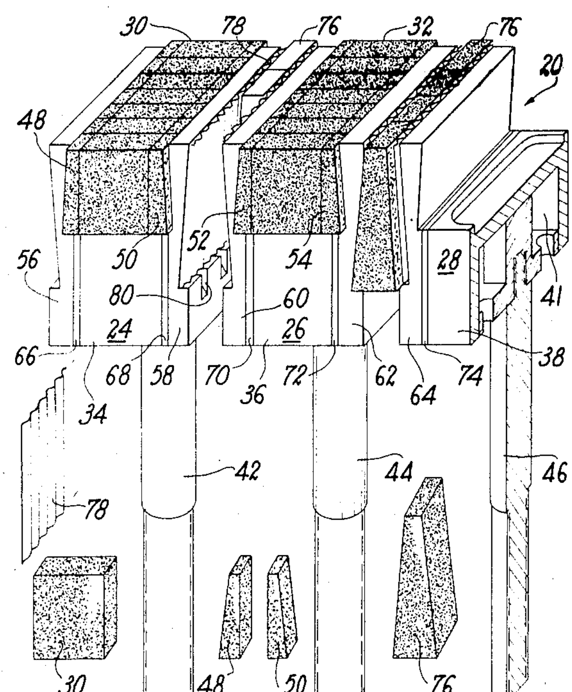
[57] **ABSTRACT**

The composite wall is constituted by an assembly of identical main elements each comprising at least one ceramic block which is fitted in a metallic support. The main elements are assembled together by means of trapezoidal prismatic spacer members which are fabricated from insulating refractory ceramic material and placed between corrugated stainless steel sheets which permit a circulation of coolant gas in contact with the main elements.

8 Claims, 2 Drawing Figures



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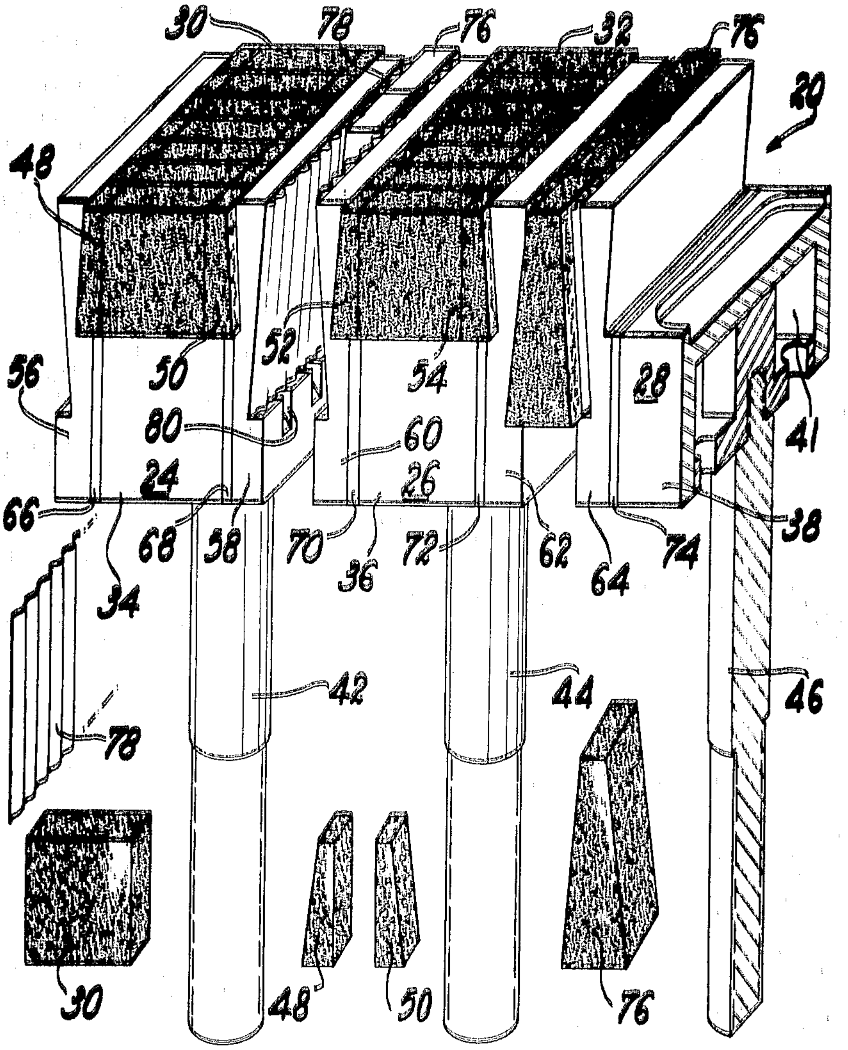
2 Sheets-Sheet 1

FIG. 1



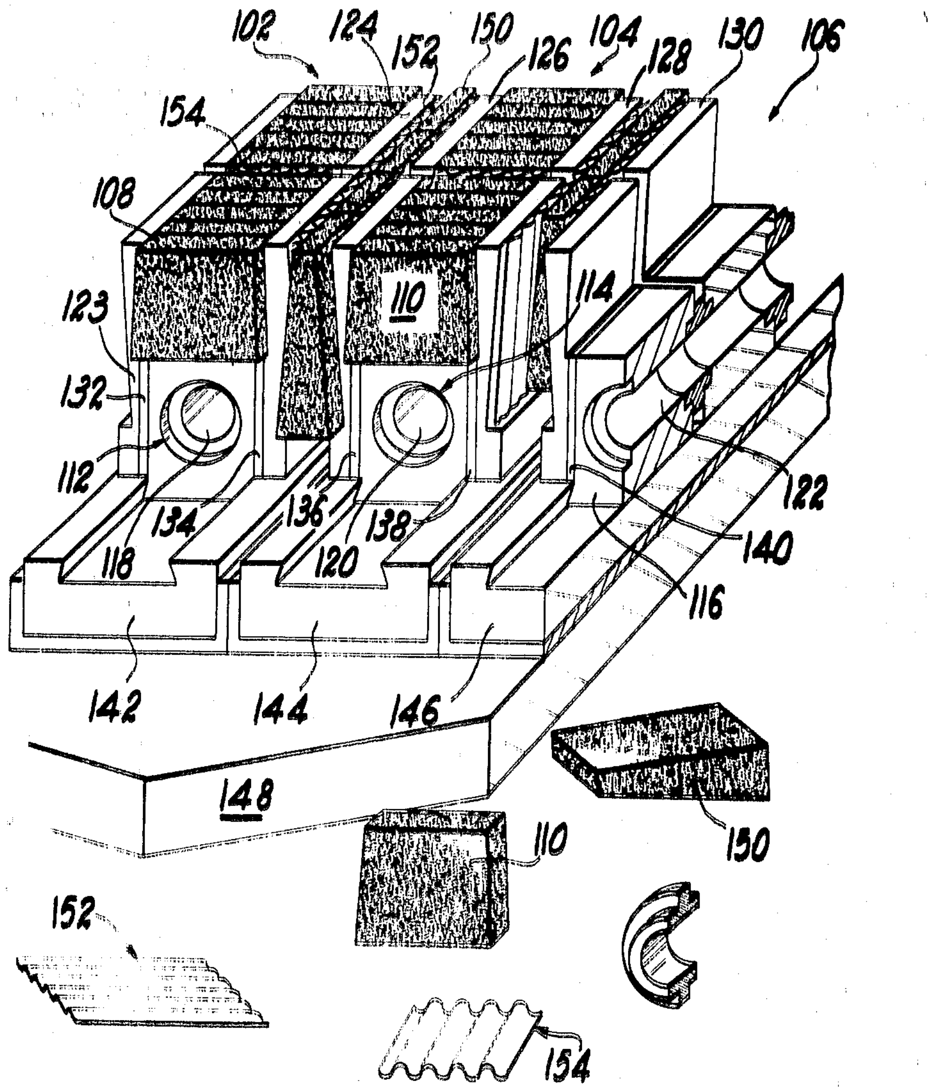

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FIG. 2

COMPOSITE WALLS FOR MHD-GENERATOR DUCTS

This invention is concerned with improvements to the composite walls of a magnetohydrodynamic (MHD) generator duct, said improvements being applicable both to the electrodes and to the insulating walls.

In MHD generators, substantial electric power losses are exhibited by some types of temperature-controlled hot walls which are constructed of ceramic elements, said elements being clamped between metallic side restraints which have a cooling function. The composite electrodes of generators of this type are liable to be short-circuited. Under these conditions, the performance of the generator is poor and results in extremely low levels of MHD conversion efficiency. It will be noted in particular that the dangers of arc formation between different electrodes can lead to ultimate destruction of the conversion duct.

The aim of the invention is to overcome the disadvantages which have just been described.

According to the invention, the composite walls of a MHD-generator duct are constituted by an assembly of identical main elements each comprising several types of particular elements. The characteristic feature of this arrangement lies in the fact that the main elements are assembled by means of trapezoidal prismatic spacer members which are fabricated from insulating refractory ceramic material and placed between two corrugated sheets, said sheets being formed especially of stainless steel.

Said trapezoidal prismatic spacer members of insulating and refractory ceramic material can be fabricated either from magnesia MgO or from strontium zirconate $SrZrO_3$.

Grooves for the purpose of circulating a coolant gas at low pressure can be formed in the metallic members which serve to support the corrugated stainless steel sheets.

The main elements of said walls can be divided into a plurality of sections by means of corrugated stainless steel sheets which are disposed transversely.

Apart from these main arrangements, the invention is also concerned with a number of secondary arrangements which will be mentioned hereinafter and relate to one embodiment of the invention.

The characteristic features which have just been described are applicable both to the electrodes and to the insulating walls.

In order to gain a better understanding of the present invention and its different technical advantages, there will now be described two exemplified embodiments which are illustrated respectively in two figures.

FIG. 1 is a partial illustration of a composite electrode which entails the application of the invention and

FIG. 2 is another partial illustration of a composite insulating wall.

The application of the invention which is shown in FIG. 1 relates to the construction of a composite electrode **20**. The external face of this latter is flush with the surface of one duct wall which is parallel to the magnetic field. Said electrode is made up of a plurality of identical main elements **24, 26** and **28**, the last-mentioned element being shown in longitudinal cross-section and each main element being constituted by several types of particular elements. A main element comprises current-collecting elements **30, 32**, the external surfaces of which form part of said duct face. The rear faces of said current-collecting elements are in contact with a rear component **34, 36** or **38** formed of copper and cooled by a water circulation passage **41** which is visible in the case of the main element **28**. Said components are rigidly fixed to threaded fastening rods **42, 44** and **46**. The ceramic current-collecting elements **30, 32** are located between heat-insulating ceramic elements **48** and **50** or **52** and **54**. The elements of both types thus form ceramic blocks which are in contact with each other by means of platinum grids (not shown in the drawings). Said grids improve the transmission of electric current from the front of the electrode to the copper components. The temperature of said grids must remain lower than 1,700° C. in order to prevent melting.

It should be noted that the electrically conductive ceramic elements which perform the function of current collectors (namely the elements 30, 32 of zirconia ZrO_2 or lanthanum chromite $LaCrO_3$, for example) as well as the heat-insulating and electrically conductive ceramic elements (namely the elements 48, 50 or 52, 54 or magnesia MgO or strontium zirconate $SrZrO_3$) which are employed in a composite electrode structure are disclosed in the co-pending French patent application as filed in the name of the present Applicant in respect of "MHD-generator electrode which is insensitive to the action of alkali-metal seed material."

The assemblies consisting of current-collecting elements and insulating blocks as well as rear components of copper are securely held in position between metallic members **56, 58–60, 62–64**, etc., the surfaces of said members which are in contact with the hot gases being made of stainless steel. In order that the copper-stainless steel junction may readily be formed, the members **56, 58–60, 62–64** are machined in a stainless steel and copper laminate. The weld joints **66, 68, 70, 72** and **74** between the components which are partly composed of stainless steel and the copper components are therefore formed between the surfaces of the last-mentioned metal (copper) and very intimate contacts are thus established.

It will be noted that the structure of the metallic support of each main electrode element is such that the parts which are in contact with the gases are of stainless steel while those which are cooled are of copper. In consequence, the temperature at the external surface of the electrodes is not below the range of 950° C. to 1,000° C. which stainless steels are capable of withstanding and is not lower than the temperature of liquefaction of the seed material.

The main elements **24, 26** and **28** of the composite electrode are assembled mechanically by means of prismatic spacer members **76** having a trapezoidal cross-section and formed of insulating refractory ceramic material. These elements are preferably fabricated from magnesia MgO or from strontium zirconate $SrZrO_3$.

Moreover, the alkali-metal salts which constitute the seed material are liable to migrate within the spacer members and to short-circuit the main elements which are intended to the insulated. In order to forestall this danger, corrugated stainless steel sheets **78** are placed between the ceramic spacer members **76** and the supporting members **56, 58, 60, 62** and **64** which are partly made up of stainless steel. The thickness of said stainless steel sheets is comprised between 5/100 mm and 5/10 mm. Grooves **80** are formed in said members **56** . . . , **64** in order to permit circulation of compressed air under low pressure along the grooves of said corrugated sheets.

To this end, the complete MHD-generator duct assembly is placed within a sealed enclosure into which air is blown under a pressure which is higher than atmospheric pressure by a few millimeters of mercury. Said air penetrates through the grooves **80**, flows upwards along the corrugations of the stainless steel sheet **78** so that the droplets of seed material which may form between spacer members and corrugated sheets are continuously driven back into the hot gas stream which flows through the duct but without producing any disturbance within this latter (as a result of the low air pressure).

Complete electric insulation is provided between the main elements of the electrode and the corrugated sheet-metal components **78** also perform in this embodiment the function of a spring which provides compensation for the expansion of the different elements between non-operating and operating temperatures.

FIG. 2 relates to a portion of insulating wall **100** which is also made up of identical main elements **102, 104** and **106**, the element last mentioned being shown in longitudinal cross-section, each element being made up of several types of particular elements.

Each main element comprises parallelepipedal blocks **108, 110** and these latter are each in contact with a copper component **112, 114, 116** which is cooled by means of a water circulation duct **118, 120** and **122**. Platinum grids (not shown) which are placed between the ceramic blocks ensure good thermal contact and the temperature of said grids must remain lower than 1,700° C. in order to prevent melting.

The assemblies consisting of insulating ceramic blocks **108**, **110** and of rear copper components **118**, **120**, **122** are clamped in position between the metallic members **123**, **124**, **126**, **128** and **130**, those surfaces of said members which are in contact with the hot gases being of stainless steel. In order that the copper-stainless steel junction between the metallic members and the cooled blocks may readily be formed, the above-mentioned metallic members are machined in a stainless steel-copper laminate. The welded joints **132**, **134**, **136**, **138** and **140** between the members which are partly made of stainless steel and the copper components are therefore formed between surfaces of the last-mentioned metal (copper).

The wall elements **102**, **104** or **106** are securely assembled together by means of a support piece **142**, **144** or **146** in which is formed a groove, the copper component **118**, **120** or **122** being intended to engage in said groove. Said support pieces rest on a metallic base **148**.

The main elements **102**, **104** and **106** of the composite wall are assembled mechanically by means of prismatic spacer members **150** of trapezoidal cross-section which are fabricated from electrically insulating and refractory ceramic material. Said elements are preferably formed of magnesia MgO or of strontium zirconate $SrZrO_3$.

For the same reasons as in the case of the electrode of FIG. 1, any danger of migration of seed material in liquid form is prevented. Corrugated stainless steel sheets **152** are accordingly placed between the ceramic spacer members **150** and the parts **122**, **124**, **126**, **128** and **130** of the metallic supporting members which are partly formed of stainless steel. In this case also, the thickness of said sheets is comprised between 5/100 mm and 5/10 mm.

Corrugated stainless steel sheets **154** can be placed transversely to the main elements in order to divide these latter into a plurality of insulated sections.

Electric insulation of the main elements of the composite wall is thus complete and, in this case also, the corrugated

sheet-steel members **152** perform the function of springs which serve to compensate for expansion of the different elements between non-operating and operating temperatures.

Actual tests performed with a composite wall of this type have clearly demonstrated the fact that the wall makes it possible to prevent any loss of electric power.

We claim:

1. A composite wall for a MHD-generator duct and constituted by an assembly of identical main elements each comprising at least one ceramic block in a metallic support, wherein the main elements are assembled by means of trapezoidal prismatic spacer members fabricated from insulating refractory ceramic material and located between corrugated sheets which are formed of stainless steel and permit a circulation of coolant gas in contact with said main elements.

2. A composite wall for a MHD-generator duct and in accordance with claim 1, wherein the trapezoidal prismatic spacer members are formed of magnesia MgO.

3. A composite wall for a MHD-generator duct and in accordance with claim 1, wherein the trapezoidal prismatic spacer members are formed of strontium zirconate $SrZrO_3$.

4. A composite wall for a MHD-generator duct and in accordance with claim 1, wherein the thickness of the corrugated stainless steel sheets is comprised between 5/10 and 5/100 of a millimeter.

5. A composite wall for a MHD-generator duct and in accordance with claim 1, wherein the wall is an insulating wall.

6. A composite wall for a MHD-generator duct and in accordance with claim 1, wherein the main elements are divided into a plurality of portions by corrugated stainless steel sheets which are disposed transversely.

7. A composite wall for a MHD-generator duct and in accordance with claim 1, wherein the wall is an electrode.

8. A composite wall for a MHD-generator duct and in accordance with claim 1, wherein grooves which permit circulation of a coolant gas under low pressure are formed in the parts which support the corrugated sheets.

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