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COMBUSTION CHAMBER PARTICULARLY FOR MAGNETO-GAS-DYNAMIC MACHINES

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Fig. 1.

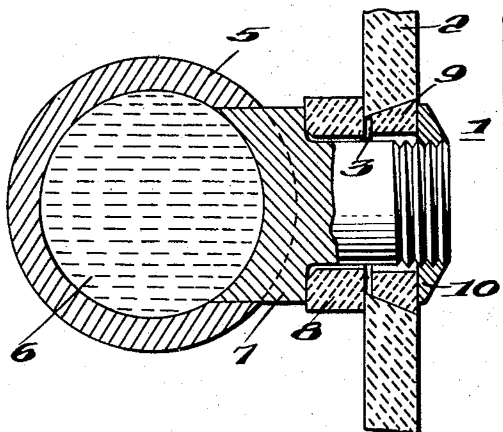

Fig. 3.

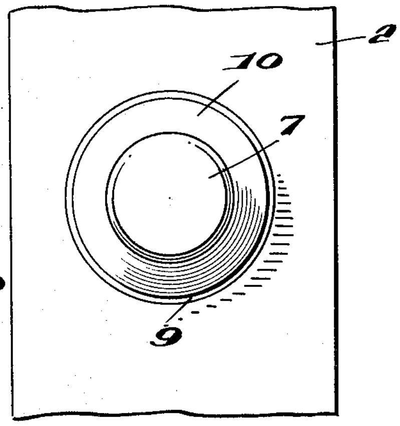

Fig. 2.

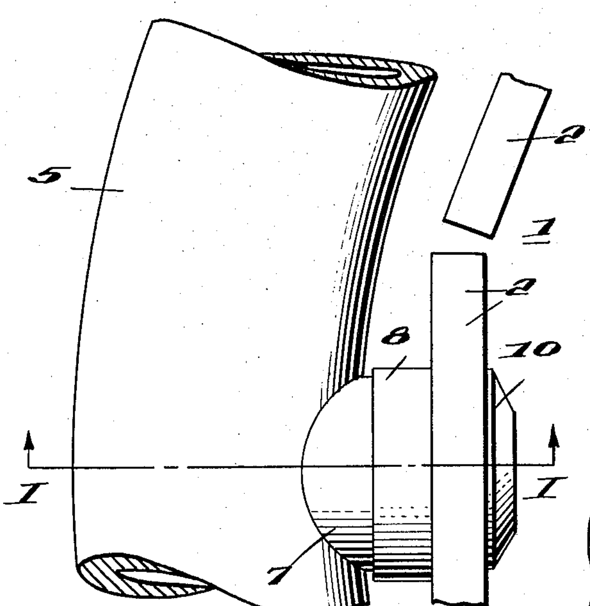

Fig. 4.

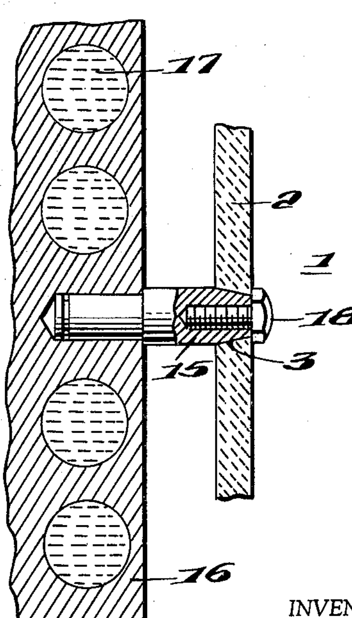

Fig. 5.

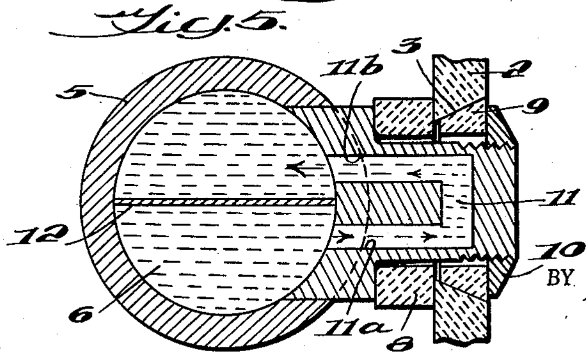

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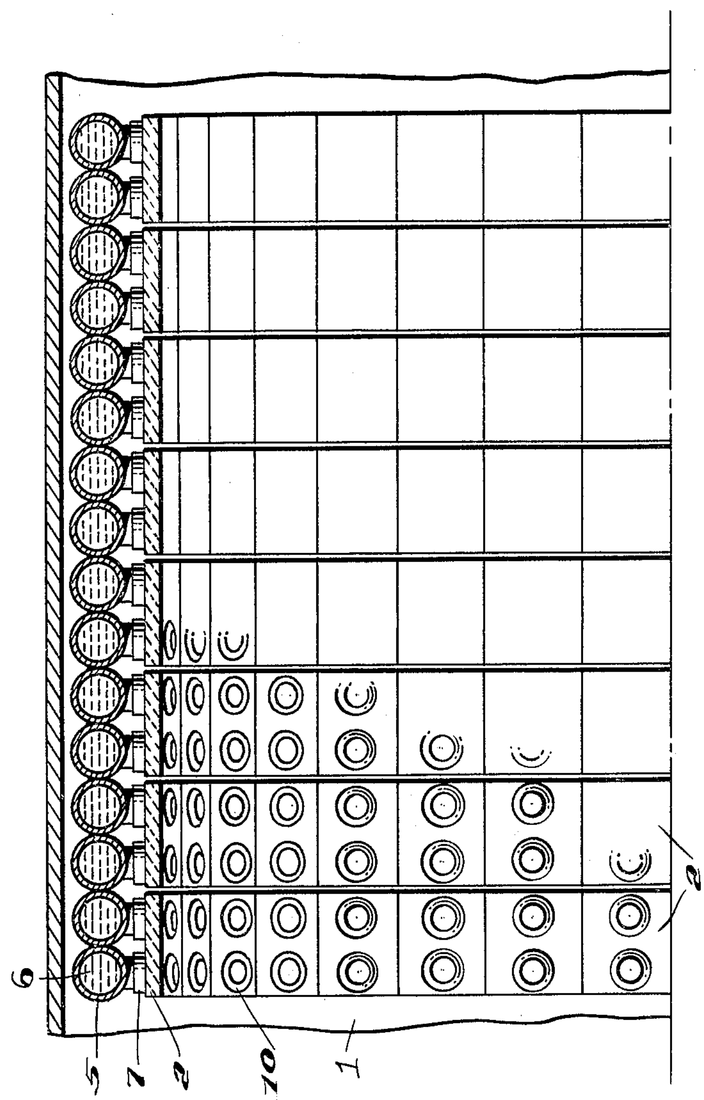
Fig. 6.



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COMBUSTION CHAMBER PARTICULARLY FOR MAGNETO-GAS-DYNAMIC MACHINES

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6 Claims. (Cl. 122—235)

The present invention relates to a combustion chamber with special reference to those used in conjunction with magneto-gas-dynamic generators for supplying a hot ionized fluid for flow through the generator.

In the construction of walls of combustion spaces both metallic and ceramic materials are employed, according to the applied purpose and temperature range of the former.

A metallic wall is then chosen if either heat is to be drawn directly from flames (boiler) or high heat losses to the wall are not of disadvantage (gas-turbines).

Conversely should the flame have to be guarded from too high radiation losses, or should an adequate cooling of the wall be undesired or cannot be guaranteed, then a ceramic wall may be well suited to practical application.

With very high temperatures and relatively high coefficients of emission for the flame, a very large portion of the heat generated is given up to a cooled, metallic wall. The combustion does not then take place adiabatically and the flame temperature remains considerably below theoretically attainable maximum stoichiometric value.

At the high temperatures attainable with stoichiometric mixtures, the danger is present that very highly insulated ceramic walls melt at the flame-side surface. This melting can progress so far that the strength of the walls is endangered.

With cyclone burners for pulverized-fuel burning, a combination of a water-cooled wall with a ceramic coating can be employed. At the same time the molten ash sticks to the cooling tubes and thus protects them from damage due to the fire. The disadvantage of this design is that practically only pulverized fuel can be burned since fuel-oil produces too little slag and the slag which is formed is in any case unsuitable.

In order to obtain the very high temperatures required in magneto-gas-dynamic machines, it is important that the heat losses from the flame to the combustion chamber will be kept as low as possible. Otherwise, despite recuperation, the desired flame temperature will not be achieved.

The jump from flame temperature to the permissible operating temperature of the wall is nonetheless so large that significant heat-flow rates must be reckoned with. The heat incident on the wall can be extracted advantageously with the aid of water-cooling. The technical realization of a ceramic wall being both water-cooled and compact is fraught with considerable difficulties, especially due to thermal expansion.

The designs employed heretofore for combustion-chamber claddings are thus unsuitable for machines of this type. The present invention has for its object the creation of a combustion chamber suitable for such use. The invention is distinguished by one or more cladding elements consisting at least partially of ceramic and being held in place with cooled support-pieces.

Constructional examples of the improved combustion chamber according to the invention will not be described and are illustrated by means of the accompanying drawings wherein:

FIG. 1 is a section taken on line 1—1 of FIG. 2 through part of a combustion chamber, schematically represented;

FIG. 2 a view of the cros-section part represented in FIG. 1;

FIG. 3 shows a cladding element from the front;

FIG. 4 is a cross-section from another embodiment of combustion-chamber, analogous to FIG. 1;

FIG. 5 is a cross sectional view similar to FIG. 1 showing a further modified construction wherein the plugs which support the cladding elements are made in hollow form; and

FIG. 6 is a view in longitudinal section showing a portion of the interior of the combustion chamber.

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With reference now to the drawings, a combustion-chamber **1** for a magnetic-gas-dynamic generator machine is cladded with small plate-elements **2**, made from a fire-resisting material which is preferably ceramic or a corresponding material with ceramic additives. A suitable all-ceramic material is, for example, a sintered metal oxide, carbide, silicate orboride. A suitable compound for the plate-elements **2** is one made of ceramic and metal such as the so-called "Cermet." Each of these cladding-elements **2** is provided with a conical boring **3**. On the side of elements **2** facing away from combustion chamber **1** is situated a cooling system, a cooling tube **5** of which latter being depicted in FIGURES 1 and 2. In the inside of tube **5** flows a liquid coolant **6**. Tube **5** is the support for the holding pieces shown as plugs **7**, the latter serving to accept cladding elements **2**. Elements **2** are borne on plug **7** due to the insertion of a conical tightening ring **9** within the bore **3** and are held in place by means of bearing-ring **8** and nut **10**. They are free to expand in all directions by which means the occurrence of thermal stresses and the danger of breakage of elements is avoided. Plug **7** can be either a solid plug, as is to be seen in FIG. 1, or provided with bores for the circulation of coolant **6**.

An example of a bored construtcion is illustrated in FIG. 5, the longitudinally extending bore in plug **7** being of U-form and so arranged that one leg **11***a* of the bore communicates with one circumferential half portion of the interior of tube **5** while the other leg **11***b* of the bore communicates with the other circumferential half portion of tube **5**, the two circumferential half portions of the tube being established by a partition wall **12** within the tube. Thus the coolant flows through the U-formed bore **11***a*, **11***b* in the directions indicated by the arrows out of and then back into the half sections of the interior of tube **5**.

The plugs **7** are attached to cooling tube **5** by soldering or welding, as is shown in FIG. 1. Bearing ring **8** and tightening ring **9** should preferably be made from ceramic material with a low coefficient of thermal conductivity. In place of nut **10** a closure-ring can be employed which is then soldered to plug **7**.

In FIG. 4 is represented a further constructional form of combustion-chamber cladding according to the invention wherein the cladding elements **2** are fixed to plugs **15** driven into a cooling wall **16**, the conically formed end-piece of each plug being entered into a conical boring **3** provided in each cladding element **2**. With this arrangement, each cladding element **2** is fixed in place in the plug **15** by means of a headed bolt **18** which is screwed into the end of the plug. Cooling wall **16** is provided with coolant channels **17**.

The configuration of cooling wall **16** conforms to the shape of combustion chamber **1**, which is constituted by the assembly of cladding elements **2**. Cooling wall **16** carries as many plugs **15** as are necesary to clad combustion chamber **1** with cladding elements **2**.

As is shown in FIG. 2, adjacent cladding elements **2** possess sufficient play in the cold condition to avoid coming into contact in the operating condition of the combustion chamber.

The thickness and material of the plate-shaped cladding elements **2** should be so chosen that the temperature of the side closest to the water-cooled wall **16** or, to the water-cooled cooling-tube **5**, respectively, still remains so high that the heat from the cladding elements **2** can be given up through radiation to the cooled region.

Basically it is also possible to employ larger cladding elements and to support them with a plurality of cooled plugs. Such an arrangement is shown in FIG. 6. The plugs **7** or **15**, respectively, are made from a very good heat-conducting material, e.g. copper.

The cooling of these cladding elements takes place through radiation to the cooling tubes or to the cooling walls respectively so that these elements are free from direct contact-cooling: this then significantly reduces the risk of temperature stresses in these elements and their premature destruction.

With a suitable form for the cladding-elements and cooling walls it is possible to balance the heat transfer due to radiation so that the maximum permissible temperature as dictated by the material employed in the cladding elements can be maintained.

The design as described thus allows operation of the combustion chamber with minimum heat losses and high flame temperatures.

We claim:

1. A combustion chamber for a magneto-gas-dynamic generator, the wall of said combustion chamber being comprised of an assembly of mutually spaced individual cladding elements made at least partially from ceramic material, a supporting member surrounding said combustion chamber, said supporting member including an internal channel through which a liquid coolant is circulated and support pieces having a high heat conductivity characteristic extending between and secured at opposite ends thereof to said supporting member and to each of said cladding elements for transferring heat from said cladding elements to said liquid coolant.

2. A combustion chamber structure as defined in claim **1** wherein said supporting member is constituted by a tube through which the liquid coolant circulates and said support pieces are constituted by plugs having one end

secured to said tube and the other end secured within a bore in said cladding element.

3. A combustion chamber structure as defined in claim **1** wherein said supporting member is constituted by a tube through which the liquid coolant circulates and said support pieces are constituted by plugs having one end secured within a bore in said tube in direct contact with the coolant and the other end secured within a bore in said cladding element.

4. A combustion chamber structure as defined in claim **3** wherein each said plug includes a channel therein communicating with the interior of said tube for circulating the coolant.

5. A combustion chamber structure as defined in claim **1** wherein said supporting member is constituted by a wall provided with a plurality of said internal channels for liquid coolant circulation.

6. A combustion chamber structure as defined in claim **1** wherein said supporting member is constituted by a tube through which the liquid coolant circulates and said support pieces are constituted by plugs having one end secured to said tube, the other end of each said plug being threaded and secured to the correlated cladding element by means including a nut threaded onto the end of the plug which passes through a bore in the cladding element, said nut bearing against a tapered ring lining the bore in said cladding element and having a heat conductivity characteristic lower than the latter, and there being a second ring of a material having a heat conductivity characteristic lower than that of said cladding element surrounding said plug at the side of said cladding element opposite to said nut and seated between a shoulder on said plug and the side of said cladding element, said rings by being interposed between said cladding element and its supporting plug serving to establish a controlled reduction in the rate of heat transfer between each said cladding element and its supporting plug.

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SAMUEL LEVINE, *Primary Examiner.*