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G. M. DREHER
COMBUSTION APPARATUS
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2,382,301

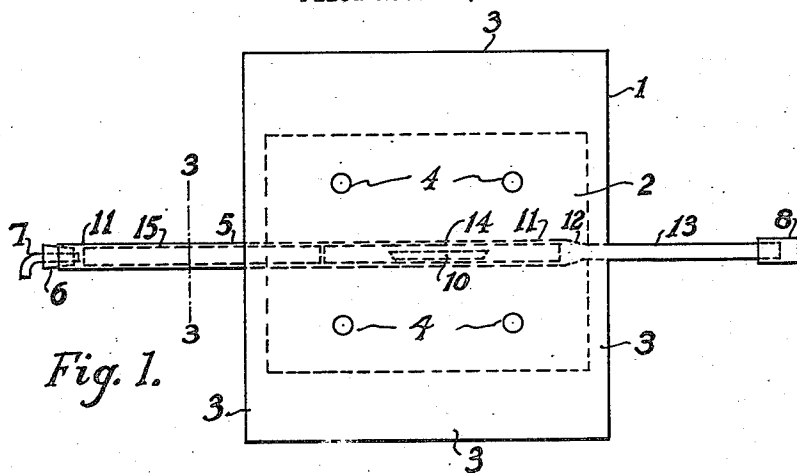


Fig. 1.

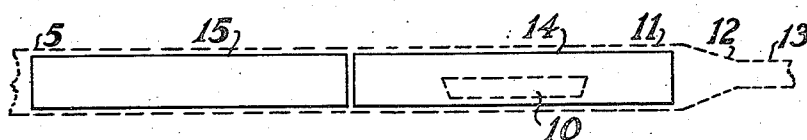


Fig. 2.

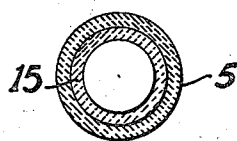


Fig. 3.

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COMBUSTION APPARATUS

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3 Claims. (Cl. 23—253)

My invention relates to combustion apparatus for chemical analysis and more particularly for the purpose of determining the carbon and sulfur content of steel and iron.

One of the objects of my invention is to provide in combustion apparatus, a combustion tube having a plurality of removable liners disposed end to end within the tube whereby to greatly prolong the life of the tube, to lower the cost of replacement of a liner and to reduce the volume of the gases to be analyzed.

Another object of my invention is to provide a combustion tube of the type above described with a substantially reduced diameter throughout the length extending approximately from the rear of the combustion chamber of the electric furnace to the end of the tube, in a relatively cool zone at some distance to the rear of the furnace whereby to still further reduce to a minimum the volume of gases to be analyzed with the consequent saving in time in making an analysis.

Other objects relating to the details and economies of the invention will appear from the description to follow. The invention is defined and pointed out in the claims.

A preferred embodiment of the invention is illustrated in accompanying drawing in which:

Fig. 1 is a side elevation of an electric furnace, conventionally shown, with a combustion tube in operative position in the furnace.

Fig. 2 is a side elevation of the liners showing the same somewhat enlarged and within the dotted outline of the combustion tube.

Fig. 3 is an enlarged sectional view of the combustion tube and a liner therefor on the line 3—3 of Fig. 1.

On the drawing reference numeral 1 designates an electric combustion furnace having a combustion chamber 2, shown in dotted outline in Fig. 1, and insulating walls 3 of any suitable refractory material surrounding the same. Electric heating elements 4 extend through the combustion chamber 2 and also through the side insulating walls thereof to the exterior on the opposite sides of the furnace for connection of the ends thereof to any suitable source of electricity. These heating elements and the particular arrangement thereof within the furnace are a part of the subject matter of my copending application, Serial Number 439,453, filed May 7, 1942.

A combustion tube 5 of any suitable refractory material passes through the front and rear insulating walls 3 of the electric furnace 1 and also through the combustion chamber 2 and between

the electric heating elements 4 as shown in Fig. 1. This tube extends for a considerable distance beyond the front and rear walls of the furnace, so that the ends of the tube are at some distance from the heat of the furnace to permit the use of tight fittings, as rubber stopper 6 and rubber hose 8 or other fitting, the stopper 6 being removable for the insertion of the combustion boat 10 containing sample to be burned and also perforated for the insertion of tube 7 leading to the oxygen supply, the hose 8 or other fitting leading to apparatus not shown for determining by volumetric and other analysis, the carbon and sulfur content of the sample burned in the boat 10.

The tube 5 has a long enlarged portion 11 connected by a relatively short tapered portion 12 to the reduced end portion 13, the enlarged portion 11 extending from where the oxygen enters the combustion tube 5 to the tapered portion 12 and the reduced portion 13 extending from the tapered portion 12 to where the burned gases leave the tube 5, the short intermediate tapered portion 12 being located at approximately the rear of the combustion chamber 2 as shown in Fig. 1. Located within the enlarged portion 11 of the tube 5 are two removable liners 14 and 15 of any suitable refractory material. These liners are disposed end to end and extend for substantially the full length of the enlarged portion 11. They may be of the same length and of the same external diameter and also the same internal diameter, so as to be interchangeable. With the combustion boat 10 in the liner 14 and the liner in the combustion tube 5 and combustion chamber 2 as shown in Fig. 1 said liner shields the inner walls of the tube 5 from the spattering iron slags above the combustion boat 10 when the highly heated sample of iron, steel or other material is burned by the passage of oxygen or other gas over the same. After a certain amount of slag has accumulated on the inner walls of the liner 14, the boat can no longer be placed in the same in which event the liner 14 may be replaced by a new liner at a small fraction of the cost of a new combustion tube 5. The liner 15 in the outer end of the tube 5 not only reduces the volume of the tube 5 with the consequent reduction of the volume of the gases to be analyzed but also aids in sliding the combustion boat 10 into liner 14. Also the outer end of the forward liner 15 being relatively close or adjacent the forward open end of the tube 5 greatly facilitates, by reason of improved visibility, the sliding of the boat 10 into said liner, to be passed therethrough into the liner 14.

Since only that portion of a liner is slagged

which is in the vicinity of a boat 10 it is advantageous that the liner for substantially the full length of the enlarged portion 11 be made of two parts as above described, rather than a single long liner for then replacement can be made by a single short liner instead of a long liner. A further advantage of making the liner of two separate short parts instead of a single integral long part is that the short part can be made at less cost and more uniform as to size and shape than a single long part due to warpage in the process of baking the same. Also two short liners will more advantageously fit a combustion tube containing any imperfections in shape caused in the manufacture of the same or due to warpage caused by the intense heat in the use of the same. Because the tube 5 is relatively long as compared to its diameter, and is of integral construction from end to end and is of baked refractory material, warpage and distortion sometimes occur not only in the process of manufacturing the same but also in the use of the same in making a determination caused by the intense heat in the furnace in which the tube is used. When the tube is so warped it is with difficulty that a close fitting long straight liner can be fitted therein, that is a liner in length equal approximately to the length of the enlarged portion 11 of the tube 5. A plurality of close fitting straight, relatively short liners, such as the liners 14 and 15 may quite frequently be inserted into a warped enlarged portion 11 of the tube 5, into which a single close fitting straight liner equal in length to that of the combined lengths of liners 14 and 15 cannot be fitted. Also a plurality of relatively short liners of refractory material such as the liners 14 and 15, in combined length equal approximately to the full length of the enlarged portion 11 of the tube 5, are a considerably less likely to be warped not only in the process of baking the same but also in the use of the same in the electric furnace while making a determination, than is a single liner equal in length to the combined lengths of the liners 14 and 15.

With the portion 13 of the tube 5 substantially reduced in diameter and with the liners 14 and 15 extending rearwardly from adjacent the forward open end for substantially the full length of the enlarged portion 11 to adjacent the short tapered portion 12 of the tube 5, the volume of the combustion tube is substantially reduced which reduces the volume of the gases to be analyzed resulting in quicker and more accurate chemical determinations which are especially important in volumetric analysis for sulfur dioxide and carbon dioxide from combustion of sample of iron or steel in the boat 10. These quick and accurate determinations, as above described, permit the laboratories to keep up with more rapid production in the manufacture of iron and steel.

I have described my improvement in an embodiment which is very practical. I have not attempted to illustrate or describe other embodiments as it is believed this disclosure will enable those skilled in the art to adopt or adapt my improvements as may be desired.

What I claim as new and desire to secure by Letters Patent is:

1. Combustion apparatus for chemical analysis comprising a combustion furnace having a combustion chamber, a combustion tube relatively

long as compared to its diameter and of integral construction from end to end and of refractory material and extending through said chamber and for a substantial distance beyond the front and the rear of the furnace into relatively cool zones, said tube having an opening at the front end thereof for insertion of a combustion boat and for connection to an oxygen supply, said tube having an opening at the rear end thereof for passage of burned gases to be analyzed, said tube having an enlarged portion from its front end to approximately the rear of the combustion chamber, said tube having a portion of reduced diameter extending approximately from the rear of the combustion chamber to the rear end of the tube, a plurality of removable interchangeable liners of baked refractory material in said enlarged portion and disposed end to end and extending rearwardly from adjacent the entrance at the front end of the enlarged portion to adjacent said reduced portion said liners each adapted to be separately inserted into and removed from said tube, one of said liners disposed for containing the boat during the combustion of the sample therein, and another of said liners disposed for the passage of the boat therethrough into the first mentioned liner.

2. Combustion apparatus for chemical analysis comprising a combustion furnace and a combustion tube relatively long as compared to its diameter and of integral construction from end to end and of refractory material and extending through said furnace, the ends of said tube extending for a substantial distance beyond said furnace into relatively cool zones, said tube having an opening at one end thereof for insertion of a combustion boat, said tube having an opening at the other end thereof for passage of burned gases to be analyzed, a plurality of removable liners of baked refractory material in said tube and disposed end to end and extending along the length of the tube from adjacent said first named opening to substantially through said furnace said liners each adapted to be separately inserted into and removed from said tube, one of said liners disposed for containing the boat during the combustion of the sample therein, and another of said liners disposed for the passage of the boat therethrough into the first mentioned liner.

3. A combustion tube for use in an electric furnace for chemical analysis, said tube being of integral construction from end to end and of refractory material, said tube having an enlarged portion for insertion of a combustion boat and a reduced portion adjoining said enlarged portion for passage of gases from said tube to be analyzed, said enlarged portion being relatively long to permit the same to extend from a relatively cool zone outside said furnace to substantially through the furnace, a plurality of removable liners of baked refractory material disposed end to end in said enlarged portion, said liners extending from adjacent the entrance of said enlarged portion to adjacent said reduced portion said liners each adapted to be separately inserted into and removed from said tube, one of said liners disposed for containing the boat during the combustion of the sample therein, and another of said liners disposed for the passage of the boat therethrough into the first mentioned liner.

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