Sept. 9, 1952 G. M. DREHER 2,610,107

COMBUSTION ANALYSIS APPARATUS

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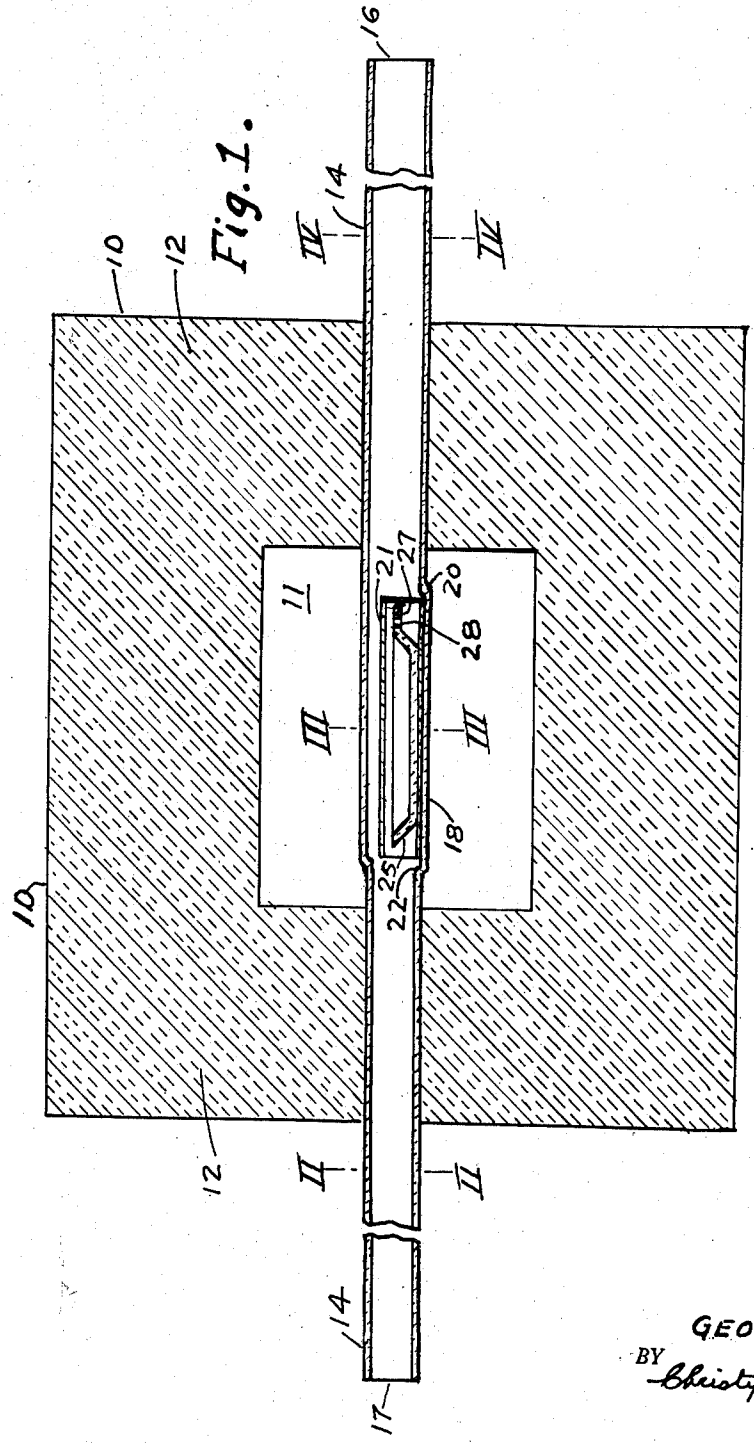


Fig. 1.

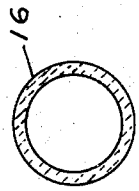


Fig. 4.

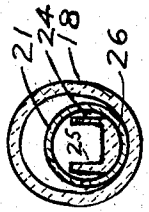


Fig. 3.

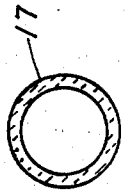


Fig. 2.

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COMBUSTION ANALYSIS APPARATUS

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4 Claims. (Cl. 23—253)

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My invention relates in general to combustion apparatus for use in chemical analysis and in particular to a novel combustion tube which may be used in the determination of the carbon and sulphur content of iron or steel.

As part of the apparatus used in making such determination, it is customary to employ a combustion tube of suitable refractory material, inside of which tube, one or more refractory liners are placed and inside one of the liners a boat of refractory material containing the sample to be analyzed is positioned. The tube is located with a portion thereof inside a heating furnace which may be a gas furnace or an electric furnace.

In determining carbon and sulphur content of a sample of iron or steel, it is customary to place the sample in a boat made from refractory material, which boat is placed inside a liner of refractory material, and the boat and liner are placed inside a combustion tube. The assembly is placed in a suitable furnace so that a portion of the assembly may be heated to a temperature say of the order of 2500° F., while a suitable gas, usually oxygen, is passed through the assembly and over the sample and into the determination apparatus.

Heretofore it has been the practice to use a combustion tube of uniform diameter throughout, or for at least the major portion of its length. When an uncovered boat is used, it is good economy to protect the tube by also using a liner which extends along the boat and is long enough to cover the boat, and small enough in diameter to be readily inserted in and withdrawn from the tube. The liner protects the tube from spattering slag, and when sufficient slag or other foreign material collects on its internal surface, it may be replaced.

The main purpose of this invention is to provide a combustion tube of improved construction which is particularly adapted to the use of a replaceable liner. To this end, the portion of the tube which is positioned within the furnace is provided with a depression in its lower internal surface in which a cylindrical liner may be placed. The depression has shoulders at its ends which are spaced apart a distance slightly greater than the length of the liner and which thus act to hold the liner in position to prevent accidental displacement of the liner in the tube. In a manner which will be described, the liner has a wall thickness substantially the same as the depth of the depression so that its internal surface constitutes a continuation of the internal surface of the inlet

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end portion of the tube whereby a combustion boat may slide freely to and from a position within the liner. The liner thus need be moved or replaced only when sufficient dirt has accumulated on its interior surface as will interfere with movement of the boat to and from a protected position within the liner.

It is an object of my invention to provide a combustion analysis apparatus having a combustion tube which has a liner receiver portion which is larger in cross section than is the balance of the tube.

It is another object of my invention to provide a combustion analysis tube which has a boat which has a shaped bottom to correspond with the inner wall of the liner in which it is placed.

It is still another object of my invention to provide a combustion analysis apparatus of such proportions that the volume of gas employed is a convenient minimum.

It is a further object to provide a combustion analysis apparatus in which the tube, the liner and the boat are so proportioned that the various needed manipulative steps may be performed and the tube so proportioned as to permit the use of a relatively low volume of gas.

It is a still further object to provide a combustion analysis apparatus which is simple, inexpensive, accurate, and which will enable relatively low cost determination of the chemical constituents of a material sample to be made by combustion analysis.

In the accompanying drawings, wherein I have shown the presently preferred embodiments of my invention:

Figure 1 is a view in vertical section of a conventional heating furnace showing my improved tube, liner and boat assembly in operative position in the furnace;

Figure 2 is an enlarged vertical sectional view of the apparatus along the line II—II of Figure 1;

Figure 3 is an enlarged vertical sectional view along line III—III of Figure 1; and

Figure 4 is an enlarged vertical sectional view along line IV—IV of Figure 1.

In the drawings, the reference numeral 10 designates a combustion furnace of known construction having a combustion chamber 11 surrounded by insulating walls 12 of any suitable refractory material. A combustion tube 14 formed of any suitable refractory material, passes horizontally through the end walls of the furnace and through the heating or combustion chamber 11. The tube 14 extends for a desir-

able distance beyond the end walls to provide at one end an inlet end 16, and at the other end a discharge portion or exit end 17.

Between the tube end portions there is a bulge or an enlarged portion 18 of greater cross sectional depth than is the inlet portion 16, which in turn is of a cross section greater than that of exit portion 17.

The upper wall of inlet portion 16 and enlarged portion 18 are in the same plane, while the lower portion of the inner wall of enlarged portion 18 is in a plane below that of the lower portion of the inner wall of inlet portion 16, when the tube is in a horizontal position. The right-hand end of the bottom of the enlarged portion or bulge 18 is connected to the bottom of the inlet portion 16 by a shoulder 20 which extends part way round the junction of the portions as seen in Figure 3. The difference in levels of the bottoms of the inner walls is substantially equal to the thickness of a refractory liner 21 which is shown in operating position in the shell of the enlarged portion 18.

The exit portion 17 of the combustion tube is of a section less than that of the enlarged portion 18, and forms at the junction with portion 18, an annular shoulder 22. There is thus provided a central portion 18 which is larger in diameter than is the inlet portion 16 and still larger than is the exit portion 17. As representative dimensions, the inlet portion 16 may have an inner diameter of about ¾ of an inch, while the exit portion may have an inner diameter of about ½ inch to about ⅝ inch. The liner 21 may be conveniently about 4'' long, of cylindrical form, with an outside diameter of about ⅝ of an inch and a uniform wall thickness of the order of about $\frac{1}{16}$ of an inch. The inner diameter of the enlarged portion 18 could well be of the order of $\frac{13}{16}$ to ⅞ inch, and the length of about 4⅛ inches long enough to receive the liner 21.

The various dimensions are such that the liner may be moved through the inlet portion 16 to the chemical determination position in the enlarged center portion 18. When the liner is placed in position between the shoulders 20 and 22, it will remain there until it is purposely moved by means of a manipulative device, such as a hooked wire. The shoulders 20 and 22 prevent accidental displacement.

The dimensions I have set forth are those of a desirable apparatus. But the measurements are exemplary only, and the dimensions adopted may be more or less as the operator desires and convenience necessitates.

I place in the liner 21 a boat 25 which I prefer to make with a bottom portion 26 shaped so as to conform to the lower portion of the inner wall of the liner. The boat has straight sides 24, and which extend to a position close to the side walls of the liner, and the ends are sloped outwardly and upwardly as shown in Figure 1. A handle 27 with an eye 28 therethrough extends to the right as shown in Figure 1. By means of a hooked wire which may be connected to this eye, the boat 25 may be moved into or out of its position inside the liner 21, which is located when in operation in the enlarged portion 18.

In the determination operation, the boat 25 with its chemical sample must be moved along the lower wall of the inlet portion and into position in the liner as shown in Figure 1. For this purpose it is highly desirable that the bottom portion of the inner wall of the liner 21 should be at least as low and preferably slightly below the lower portion of the inner wall of the inlet portion 16 of the tube, although it may be slightly above. The arrangement must be such that the boat 25 may be slid into and withdrawn from the liner in position in the enlarged portion 18 without difficulty. The height of the walls of the boat should be such as can be readily inserted in the liner, and it must be remembered that the dimensions of the various portions of the apparatus must be such as will make allowance for the variations in the finished dimensions of the various refractory articles comprising the apparatus, which by the nature of their manufacture, cannot be assuredly held to precise measurements.

In operation, the tube 14 is mounted in position within the furnace as illustrated in Fig. 1. A liner 21 is then placed in position within the enlarged portion 18 of the tube 14 with its ends positioned between the shoulders 20 and 22 at the ends of the enlarged portion 18 so that such shoulders operate to prevent accidental endwise movement of the liner 21. The furnace may then be operated to bring the portion of the tube within the furnace and its liner 21 up to operating temperature. The combustion boat 25 may then be slid over the bottom surfaces of the inlet end portion 16 of the tube and liner 21 to a position within the liner 21. The lower internal surface of the liner 21 being in substantially the same plane as the lower internal surface of the tube 16, the insertion and removal of the boat 25 may be effected without difficulty. The liner, of course, need be placed only when sufficient slag has collected on its internal surface to interfere with the flow of oxygen through the liner or the removal and replacement of the combustion boat. The dimensions of the parts, particularly the size of the enlarged portion 18 with respect to the inlet end portion 16 and the outlet end portion 17 and the formation of the end 17 with a smaller diameter than the inlet end 16, is particularly designed to maintain the internal volume of the tube at a minimum while facilitating the removal and replacement of both the liner 21 and the combustion tube 25.

While I have described the presently preferred embodiment of my invention, it is to be known that changes and modifications may be made within the scope of the following claims.

I claim:

1. In combustion analysis apparatus including a heating furnace having insulated walls defining a heating chamber therein, a combustion tube having inlet and outlet end portions extending through said walls and a center portion positioned in said chamber, said center portion having on its lower internal surface a depression providing shoulders spaced from each other axially of the tube, and a cylindrical protective liner having a length slightly less than the spacing of said shoulders for insertion in said tube to a position in which said shoulders act as abutments for preventing axial displacemet of the liner out of said depression, said liner having a wall thickness and said depression having a depth which are substantially equal so that the bottom internal surface of said liner in effect constitutes a continuation of the bottom internal surface of one of said end portions whereby a combustion boat may slide freely over said bottom surfaces in its removal from and insertion in said liner.

2. The invention described in claim 1 characterized by said central portion having a diameter

greater than either of said end portions to facilitate removal of said liner from said central portion.

3. The invention described in claim 2 characterized by said one end portion being the inlet portion, and said outlet portion having a diameter less than the diameter of said outlet portion to thereby reduce the space in said tube to a minimum.

4. In combustion analysis apparatus including a heating furnace having insulated walls defining a heating chamber therein, a combustion tube having inlet and outlet end portions extending through said walls and a center portion positioned in said chamber, said center portion having the bottom portion of its internal surface depressed below the level of the bottom portion of the internal surface of said inlet end portion to provide a shoulder between said internal surfaces, an abutment at the other end of said depressed center portion and a cylindrical liner having a length slightly less than the distance between said shoulder and abutment for insertion in said tube to a position lying on said depressed center portion, said liner having a thickness and said depressed center portion having a depth which are substantially equal so that the bottom internal surface of said liner constitutes a continuation of the bottom internal surface of said inlet end portion whereby a combustion boat may slide freely over said internal surfaces in its removal from and insertion in said liner.

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