No. 785,535. PATENTED MAR. 21, 1905.

W. C. ARSEM.

ELECTRIC FURNACE.

APPLICATION FILED AUG. 12, 1904.

2 SHEETS—SHEET 1.

FIG. 1

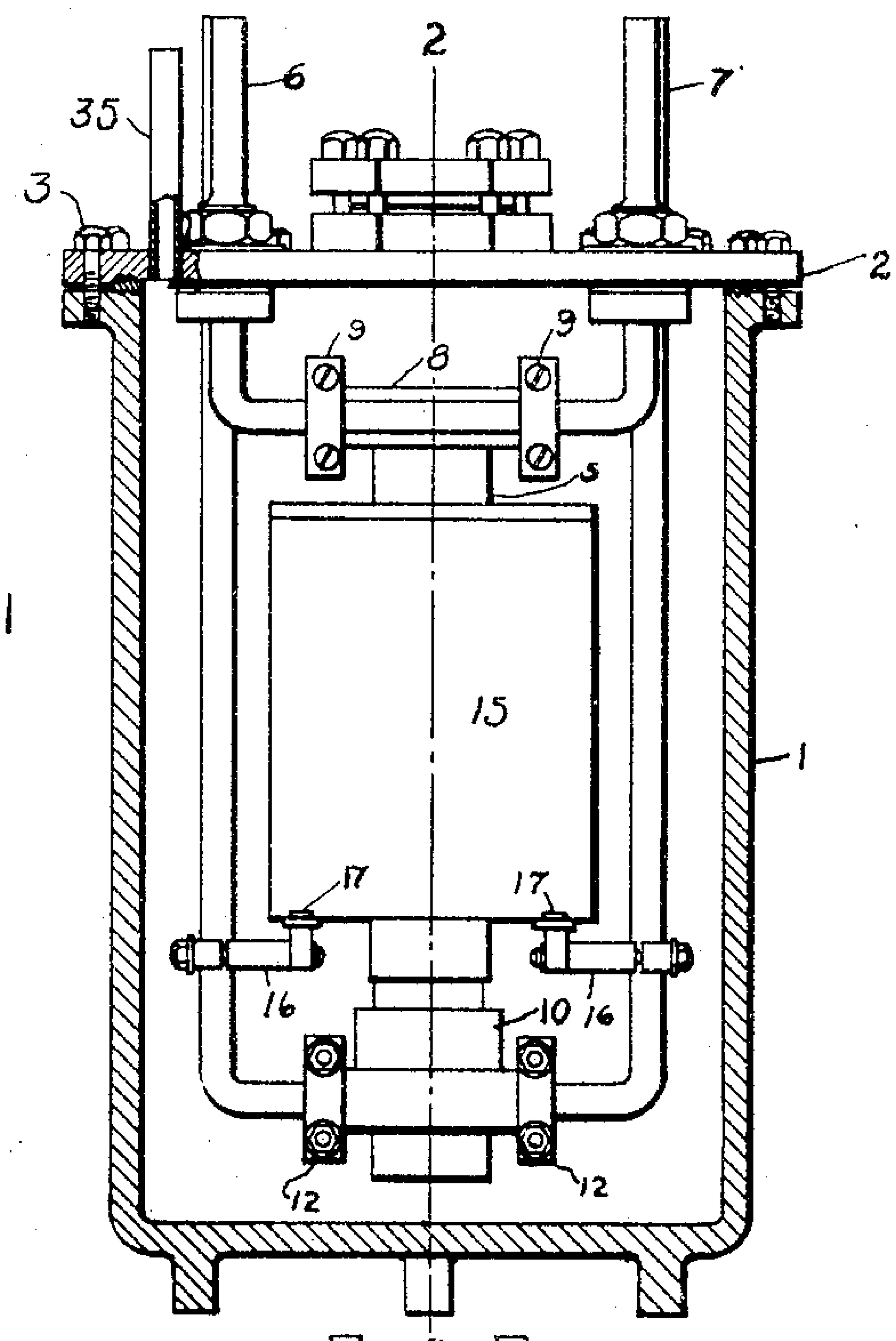
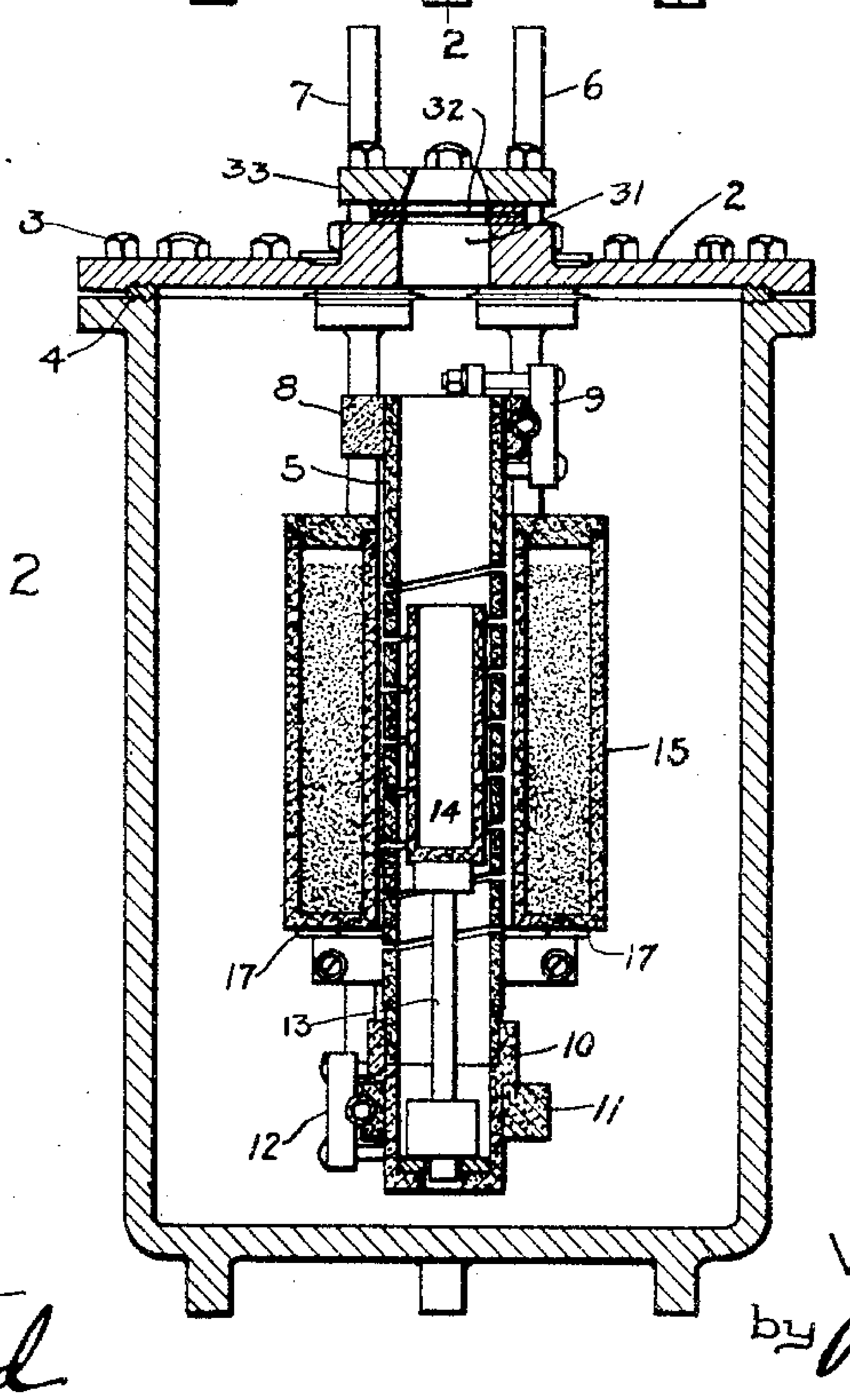


FIG. 2



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2 SHEETS—SHEET 2.

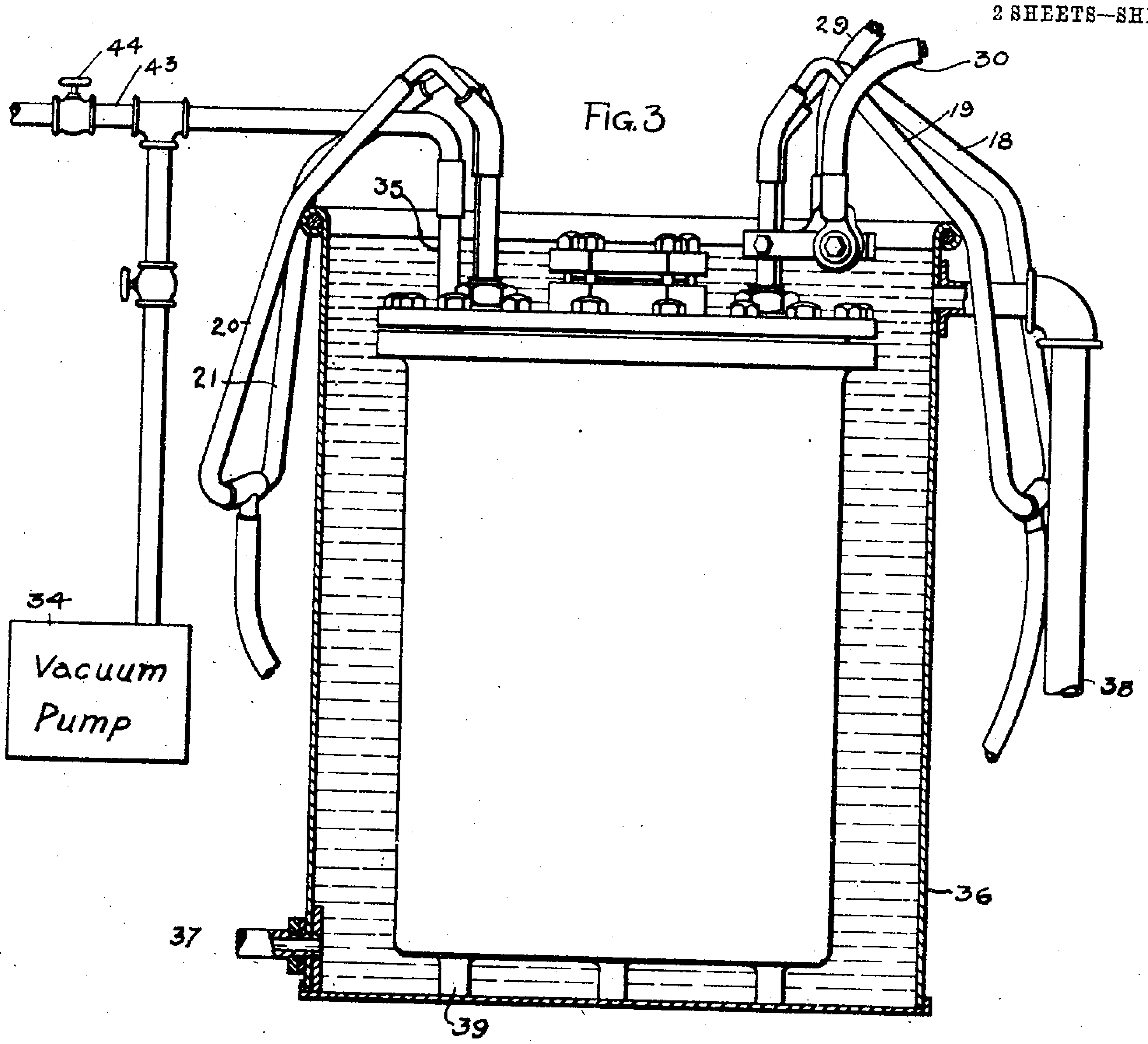

FIG. 3

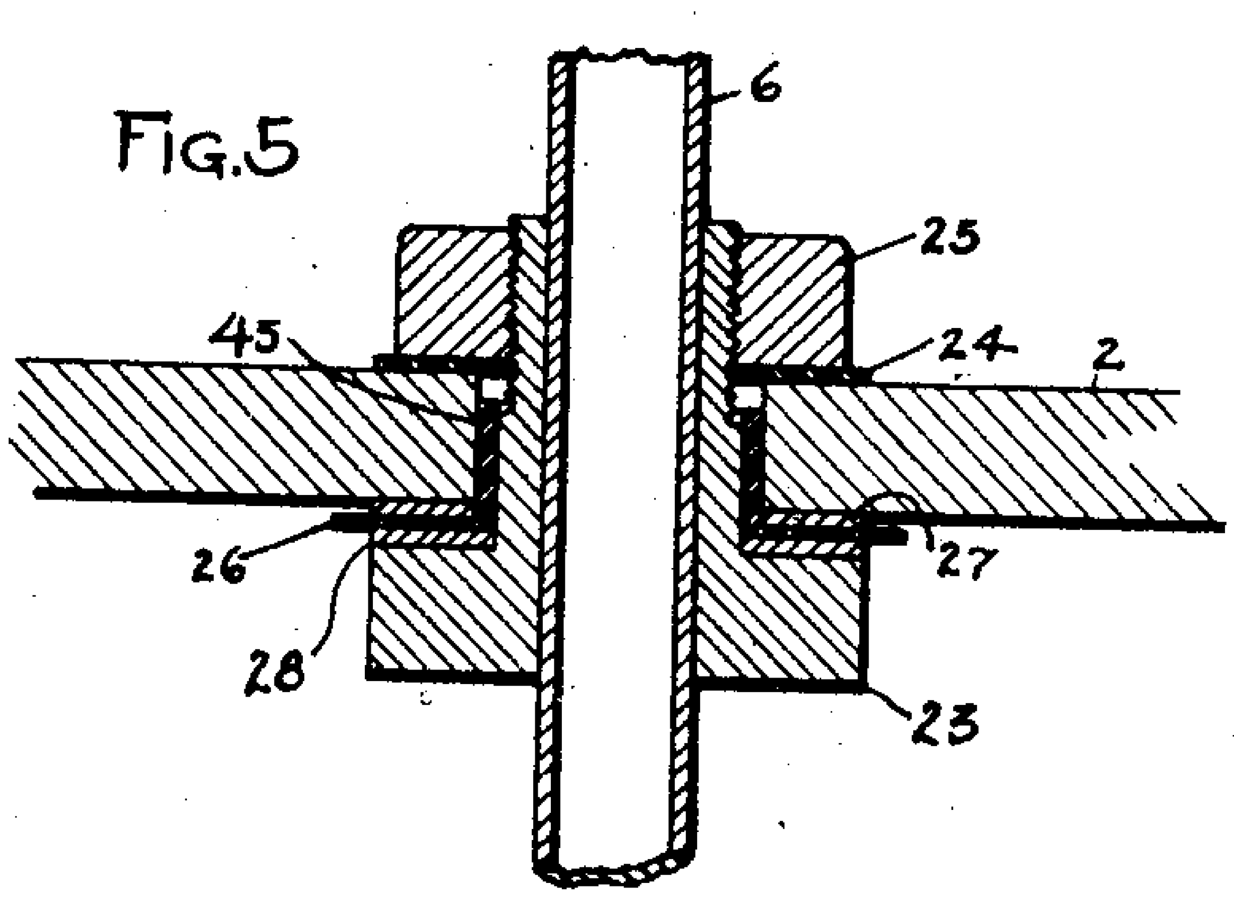

FIG. 5

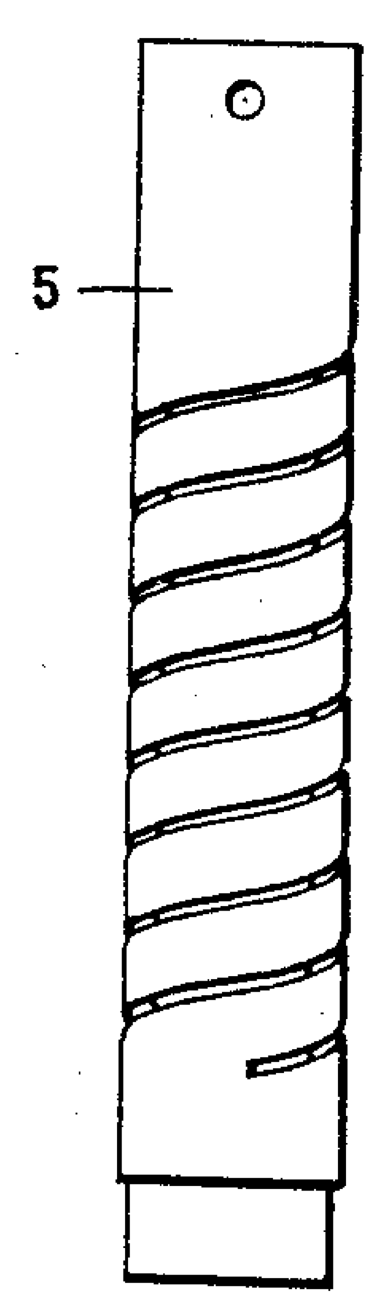

FIG. 4

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UNITED STATES PATENT OFFICE.

WILLIAM C. ARSEM, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC FURNACE.

SPECIFICATION forming part of Letters Patent No. 785,535, dated March 21, 1905.

Application filed August 12, 1904. Serial No. 220,449.

To all whom it may concern:

Be it known that I, WILLIAM C. ARSEM, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification.

The object of this invention is to provide an apparatus in which materials may be heated to a high temperature in a vacuum or in an atmosphere of any gas.

The invention will be better understood by reference to the drawings, forming a part of this specification, in which—

Figure 1 is an elevation of the furnace with one side of the vacuum-chamber cut away. Fig. 2 is a sectional elevation on the line 2 2 of Fig. 1. Fig. 3 is an elevation, partly in section, showing the vacuum-chamber immersed in a water-bath and showing also the means for cooling the heater-terminals and the means for exhausting the air from the vacuum-chamber. Fig. 4 is a detail of the refractory heater, and Fig. 5 shows the means for providing an air-tight insulated joint between the tubular conductors and the top of the vacuum-chamber.

The vacuum-chamber 1 is made of gun-metal and may be coated with tin to prevent leakage through the pores of the metal. It is cylindrical in form, the bottom being cast integral with the sides. A cover 2 is provided, which may be firmly clamped to the cylindrical member 1 by the bolts 3. An annular lead washer 4 is interposed between the cover 2 and the cylindrical member 1 to insure an air-tight joint. Narrow annular channels are cut in the two surfaces contacting with the lead washer, into which the lead is forced when the parts are drawn together by the bolts. The refractory cylindrical member 5 is suspended in the vacuum-chamber by the U-shaped tubular conductors 6 and 7. This refractory member 5 may be composed of any conducting material, but I prefer to use graphite in the form of a tubular helix. A heater of this form may be readily constructed by cutting a helical slot in a hollow graphite cylinder. The upper end of the heater fits snugly into a massive graphite terminal 8, which in turn is clamped to the tube 6 by the copper clamp 9. The tube 6 fits into a semi-cylindrical channel in the side of the terminal 8, thereby providing a good electrical contact between the two parts. The lower end of the heater 5 is supported in the cup-shaped graphite member 10, which in turn is supported by the graphite terminal 11, clamped to the tube 7 by the copper clamp 12. An annular emery washer is supported in the lower part of the cup-shaped member 10 and carries the carbon standard 13, which is used to support the crucible or other article 14 to be heated. To increase the efficiency of the furnace and to confine the heat to the radiating member and the space it incloses, a refractory screen 15 is placed around the refractory member 5. This screen comprises an annular refractory box between the inner and outer walls of which is packed pulverized graphite. The screen 15 surrounds the refractory member 5 closely, but does not make contact therewith. It rests on the copper supports 16, from which it is insulated by the lava buttons 17.

To prevent an overheating of the ends of the refractory member and the conductors leading thereto, said conductors are made hollow and water is circulated through them, as shown in Fig. 3, the water entering through the rubber tubes 18 and 19 and leaving through the tubes 20 and 21. To further prevent a destructive heating of the metal terminals, the slot in the refractory member 5 terminates some distance from the end of the tube. This gives a large cross-sectional area at the end of the tube and enough heat-radiating surface at this point to keep the temperature within reasonable limits. The tubular conductors 6 and 7 pass through the cover of the vacuum-chamber and are insulated therefrom, as shown in Fig. 5.

23 is an annular sleeve soldered to the tube 6, insulated from the cover of the chamber by the paper bushing 45, and firmly clamped against the under surface of the cover by the

nut 25, which is insulated from the cover by the paper washer 24. A mica washer 26, interposed between two lead washers 27 28, serves to form an air-tight insulated joint between the sleeve and the top. The upper washer 27 has a smaller internal diameter than the lower washer 28, so that the bushing 45 rests directly on the mica washer. This prevents the upper washer from flowing around the inner edge of the mica washer when subjected to pressure in tightening the nut 25. The tubular conducting members 6 and 7 are provided with suitable terminals 29 and 30, through which the power is supplied. The central part of the cover 2 is provided with a small annular sight-opening 31, through which the article to be heated may be observed when the furnace is in operation. This opening is provided with a mica plate 32, firmly clamped between two lead washers, the latter being held in place by the cap-plate 33.

34 is a vacuum-pump by means of which the air may be exhausted from the vacuum-chamber through the tube 35. Tube 35 also serves as a means for introducing any desired gas into the vacuum-chamber, the gas being supplied through the pipe 43, controlled by valve 44. A water-jacket 36, provided with an inlet 37 and an outlet 38, surrounds the vacuum-chamber and prevents an undue heating of the casing 1.

The casing 1 is provided with integral legs 39, so that there may be a circulation of water underneath the casing. While I may use either direct or alternating current as a means for heating the refractory member 5, I prefer to use alternating. As the heat radiation from the refractory member depends on the amount of current supplied, a very accurate adjustment and regulation of the furnace temperature may be obtained.

The apparatus described may be used for a great variety of purposes, such as the fusing of refractory substances, the reduction of metals from their compounds in an atmosphere free from oxygen, the preparation of alloys *in vacuo* or inert gas, and many other purposes, which will be obvious to a person skilled in the art.

With the apparatus described much higher temperatures can be obtained than with evacuated vessels of porcelain, quartz, or metal heated externally. Such vessels cannot resist atmospheric pressure above a comparatively low temperature, as they become permeable to gases and finally collapse. The helical form of heater used in my furnace and the fact that no earthen or other material is interposed between the heat-radiating substance and the article to be heated make it possible to secure a particularly efficient utilization of the power supplied. Furthermore, the screen which serves to shield the walls of the vacuum-chamber also assists in concentrating the heat within the comparatively small space surrounded by the heating-helix, owing to the low heat conductivity of the shield.

Any temperature up to the vaporizing-point of carbon can be obtained and constantly maintained for any length of time at a pressure of .2 millimeter or less. Since the article being heated does not come in contact with the carbon heater, no chemical action occurs between the two, and many operations can be carried on which are impossible in the ordinary types of electric furnaces in which contact of the heated substance with carbon is unavoidable.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. An electric furnace having an air-tight chamber, a refractory heater therein, means for supporting material to be heated in close proximity to said refractory heater, and means for exhausting the air from said chamber.

2. An electric furnace having an air-tight chamber, heating means therein inclosing a heating-space, means for supporting material to be heated within the space inclosed by said heater, and means for exhausting the air from said chamber.

3. An electric furnace having an air-tight chamber, and a refractory heater within said chamber, said heater consisting of a helix of conducting material.

4. A heating member for electric furnaces consisting of a helix of graphite.

5. The combination with a helical heating member for electric furnaces, of a screen surrounding said heating member, said screen serving to retain heat in the space inclosed by said heating member.

6. In an electric furnace, the combination of a refractory heater inclosing a heating-space, a screen surrounding said heater in close proximity thereto, said screen having inner and outer walls, and a heat-insulating material between said walls.

7. In an electric furnace, the combination of a helical refractory heater of graphite, a screen surrounding said heater in close proximity thereto, thereby serving to reflect heat to the space within the spiral, terminals for said heater, and means for cooling said terminals.

8. In an electric furnace, the combination of an air-tight chamber, a refractory heater within said chamber, terminals for said refractory heater, and means for cooling said terminals.

9. In an electric furnace, the combination of a refractory heater, a screen surrounding said heater, terminals for said heater, and means for cooling said terminals.

10. In an electric furnace, the combination of an air-tight chamber, a refractory heater within said chamber, said heater inclosing a heating-space, means for supporting material

to be heated within said heating-space, and a sight-opening in said chamber whereby the changes in said material may be observed.

11. An electric furnace having an air-tight chamber, a heater therein, a refractory screen surrounding said heater, and means for exhausting the air from said chamber.

12. An electric furnace having an air-tight chamber, a refractory heater therein, terminals for said refractory heater, tubular conductors leading to said terminals, means for circulating a cooling fluid through said conductors, and means for exhausting the air from said chamber.

13. An electric furnace having an air-tight chamber, a heater within said chamber, means for exhausting air from said chamber, and means for cooling said chamber.

14. An electric furnace having an air-tight chamber, a refractory heater within said chamber, means for exhausting air from said chamber, and means for introducing an inert gas into said chamber.

In witness whereof I have hereunto set my hand this 10th day of August, 1904.

WILLIAM C. ARSEM.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.