

July 18, 1950

J. WALLERIUS
LIQUID BATH FURNACE

2,515,618

Filed April 13, 1944

2 Sheets-Sheet 1

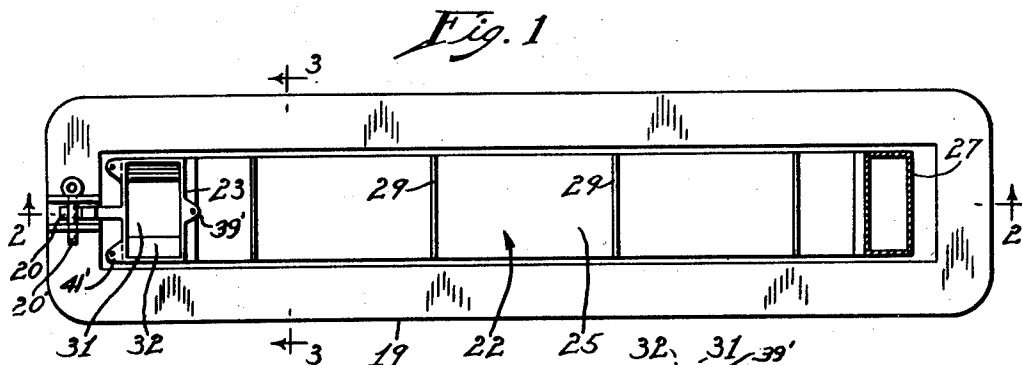
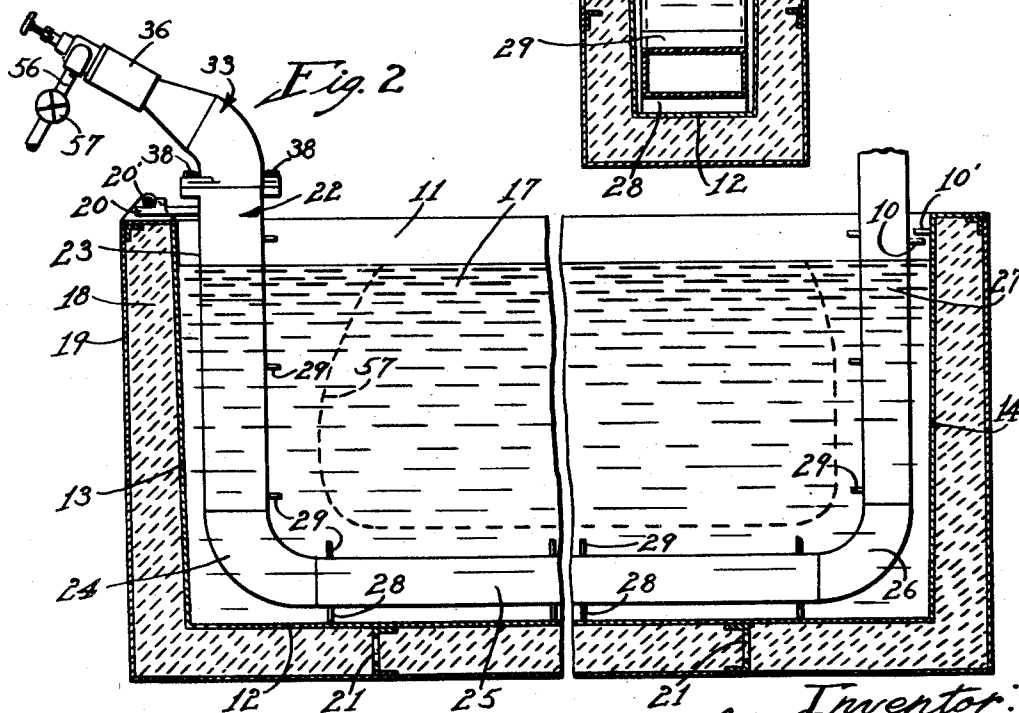
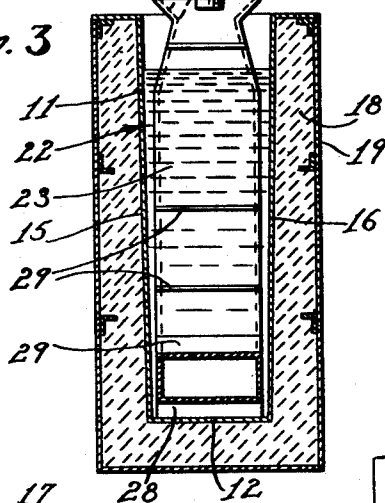


Fig. 3



Inventor:
John Wallerius
By McCanna & Horsbach
Attys.

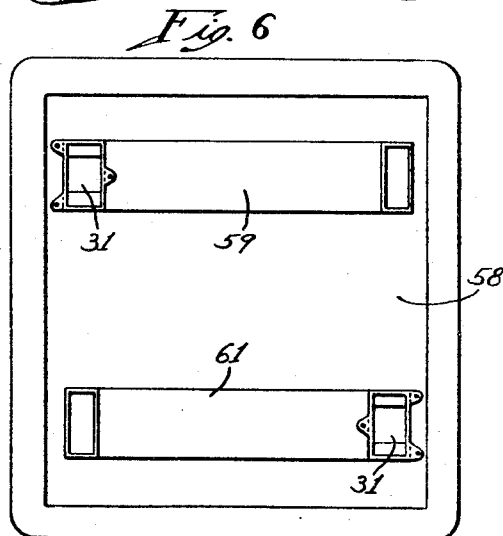
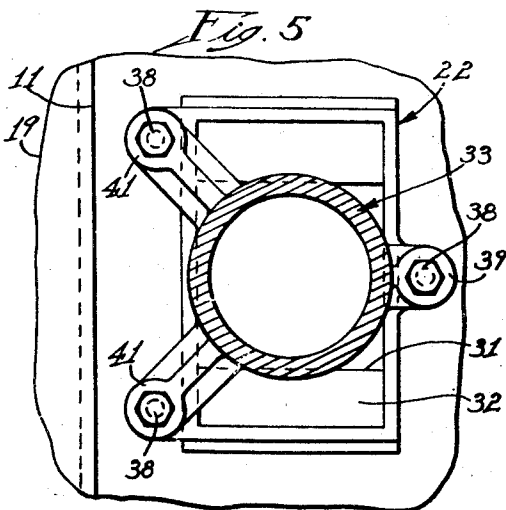
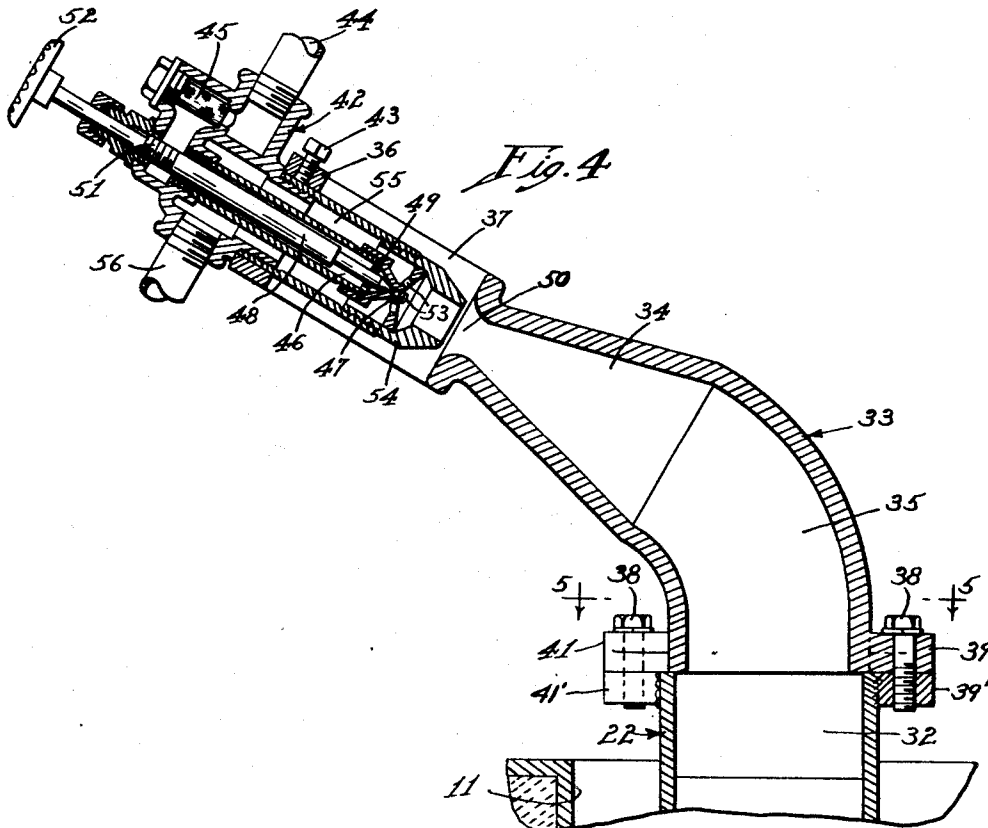
July 18, 1950

J. WALLERIUS
LIQUID BATH FURNACE

2,515,618

Filed April 13, 1944

2 Sheets-Sheet 2



Inventor:
J. Wallerius
By Mc Canna & Morabach
Attys.

UNITED STATES PATENT OFFICE

2,515,618

LIQUID BATH FURNACE

John Wallerius, Chicago, Ill., assignor to Sunbeam Corporation, Chicago, Ill., a corporation of Illinois

Application April 13, 1944, Serial No. 530,933

2 Claims. (Cl. 126—360)

1

This invention relates to heat treating furnaces of the type having a bath of heated liquid medium in which the work-piece is immersed for the heat treatment. The heating medium may be a salt such as chloride or cyanide, or it may be lead or other molten material.

Heretofore it was common practice to externally heat the pot or container which held the salt bath, usually by burners impinging against the lower portion of the pot or into a heating chamber surrounding the pot, with the result that relatively high heating temperatures were required to liquify the salt and to bring it to the desired operating temperature. This structure imposed relatively large temperature differential between the combustion chamber and the liquid bath and made it difficult to maintain critical working temperatures and uniformity in the resultant work. Furthermore, the impingement of the burner flame on the lower portion of the pot or the concentration of heat at certain areas caused deformation of the pot structure and sometimes decomposition of the bath itself because of the concentrated heat. These conditions are aggravated when workmen try to speed up the initial heating of the bath by increasing the burner flame. Furnaces of this type are comparatively heavy and bulky because of the large space required for the heating chamber surrounding the pot and the large insulation wall enclosing the heating chamber. Some of these objections have been overcome by the use of electrical heating means having electrodes immersed in the bath, but electric current is not always available and in some places the cost is prohibitive.

One of the objects of the present invention is to provide a new and improved liquid bath furnace in which liquid or gas fuel is used for heating but without the disadvantages of prior methods.

Another object is to provide a liquid bath furnace having a heating element of new and improved construction whereby the liquid bath is heated internally in a manner which promotes comparatively quick heating, reduces temperature lag, and permits greater accuracy in controlling the temperature of the bath and consequently greater uniformity in the resultant work.

Another object of my invention is to provide

2

a liquid bath furnace having improved heating means employing liquid fuel or gas as the heating medium.

Another object of the invention is to provide a furnace of the character described which will have comparatively large capacity for its size and weight and which may be economically manufactured.

Other objects and attendant advantages will be appreciated by those skilled in this art as the invention becomes better understood by reference to the following description when considered in connection with the accompanying drawings, in which:

Figure 1 is a plan view of a liquid bath furnace embodying my invention;

Fig. 2 is a vertical section taken substantially on the section line 2—2 of Figure 1;

Fig. 3 is a cross section taken substantially on the section line 3—3 of Figure 1;

Fig. 4 is an enlarged vertical section through the burner and the adjacent end of the heating element;

Fig. 5 is a section taken substantially on the section line 5—5 of Figure 4; and

Fig. 6 shows the invention as applied to a substantially square liquid bath container.

The embodiment shown in Figures 1 to 5, inclusive, is especially adapted for heat treating relatively long and narrow work-pieces and also those having substantial length and breadth but comparatively small over-all thickness. This furnace is, therefore, particularly well adapted for the heat treating of sheet aluminum fabricated for the repair of airplane structures and also for heat treating repaired airplane propellers. It will also be observed, as the invention becomes better understood, that the structure is particularly well suited for use in field shops because of its comparatively light weight and small size considering its large capacity, thus making it adaptable for portability and transportation. In this embodiment I prefer to employ liquid fuel such as fuel oil, kerosene, or gasoline, as the heating medium; and my invention provides a burner structure especially designed for this purpose. It should be understood, however, that where gaseous fuel is available and desirable for economic reasons, a gas burner may be employed with my invention.

3

Referring more particularly to the drawings, I have provided a pot or container designated generally by 11 having a bottom wall 12, end walls 13-14, and side walls 15-16, arranged to provide a long and narrow container of substantial depth and having an open top. This pot or container is preferably of steel plate, welded at the joints. In ordinary practice the container is filled with a suitable salt 17 substantially to the level shown. The bottom and side walls of the container are enclosed in suitable heat insulation 18 confined by an outer metal casing 19, supporting and spacing bars 21 being interposed between the container and the casing.

The heating element designated generally by 22 is of novel design and arrangement particularly advantageous for heat transfer to the salt medium. The heating element essentially is a long conduit having comparatively large surface area in relation to its length. The conduit is preferably of general U-shape, providing a vertical inlet length 23 which enters the salt body from the top at one end of the container and extends downwardly near the adjacent end wall 13 to an elbow 24, thence horizontally in a length 25 to an elbow 26 near the opposite end wall 14, and thence upward in a vertical outlet length 27 which leaves the salt body at an upper level, preferably through the open top of the container. As clearly illustrated in the drawings the inlet length 23 has a larger cross sectional area than the horizontal length 25 and the outlet length 27. In this embodiment the heating element is made up of steel plates of greater thickness than the plates comprising the container walls, the heating element being fabricated to the shape shown and welded at the joints. The cross section of the heating element substantially fills the width between the side walls 15-16 as shown in Figure 3 but allows space for the salt to freely circulate around the element. The heating element constitutes a unit which may be placed into position in the container and removed therefrom through the open top; and in this respect it is particularly advantageous because neither the inlet nor outlet end nor any of the burner or fuel connections extend through the side walls or the permanent wall structure of the container or of the casing proper. Suitable means such as a number of vertical spacer plates 28 are applied to the bottom of the heating element to support it in the desired spaced relation from the bottom of the container. Also a number of plates 29 are applied to the inner walls of the heating element, that is, to the innermost walls of the vertical lengths 23 and 27 and to the top wall of the horizontal length 25 at suitable intervals for the purpose of preventing the work-pieces from coming in contact with the heated element and also for maintaining the work-pieces in a uniform temperature zone in the salt bath. These plates or the equivalent may be suitably spaced and arranged for this purpose. Suitable means is provided to prevent lengthwise displacement of the heating element and also to prevent any floating tendency, comprising overlapping abutment plates 10 and 10' coacting between one end of the element and the adjacent container wall and an abutment member 20 fixed to the opposite end of the heating element and coacting with a keeper pin 20'. The inlet end of the heating element is shaped through a substantial part of its length to provide a Venturi passage 31 having a wide opening 32, as best shown in Figures 1 and 3. This venturi provides for air in-

4

jection in connection with the burner which will now be described.

I have provided a liquid fuel burner especially adapted for the satisfactory functioning of a heating element under the conditions of my invention. A preferred embodiment for the use of liquid fuel comprises a mixing tube designated generally by 33 in the form of a casting shaped to provide a Venturi inlet 34 which leads at its larger end to a passage 35 which in turn discharges into the Venturi inlet 32 of the heating element. This mixing tube casting is further shaped to dispose the passages 34 and 35 in angular relation, to provide attaching means for connection to the upper end of the heating element, and to provide a bracket 36 for support of an air and fuel valve. This bracket 36 also provides an opening 37 for the supply of secondary air to the fuel mixture which is delivered into the inlet of the venturi 34. The mixing tube casting may be detachably connected by any suitable means to the upper end of the tubular heating element, as by means of bolts 38 passing through lugs 39 and 41 integral with the casting and threaded into suitable lugs 39' and 41' on the heating element. The burner includes a fuel and air mixing unit assembled on a body designated generally by 42, this unit being inserted into an opening in the bracket 36 and clamped therein by means of a screw 43. Liquid fuel supplied through a pipe 44 passes through a filter 45 to a needle valve chamber 46 which has a center jet opening 47. A needle valve 48 coacting with the port 47 is guided at its needle end by a perforated disc 49 and is threadedly connected at its opposite end 51 with the body or housing structure so that by turning the handle 52 the delivery of liquid fuel through the jet orifice may be regulated. In this construction it will be noted that the fuel pressure of the liquid fuel is carried to the needle valve jet discharge so that the full force of the pressure is utilized in breaking up the liquid at the point of its discharge into a surrounding air stream for the purpose of atomizing the fuel. This air stream is delivered through a plurality of orifices 53 in a nozzle head 54 in which the fuel jet orifice 47 is formed. Air under pressure is supplied to these orifices 53 through a passage 55 which communicates with an air supply pipe 56 which is equipped with a suitable regulating valve 57. In this particular embodiment air is supplied under pressure of about 1 to 3 lbs. and the liquid fuel under a pressure of about 1 to 5 lbs. Said orifices 53 are arranged to deliver air jets converging on the fuel jet so as to further aid in atomizing the fuel and mix the air and fuel in a stream which is delivered under high pressure through the inlet 50 of the Venturi passage 34. This construction provides an injector action which entrains secondary air at said inlet end 50 which further mixes with the fuel in providing a combustible mixture. This mixture burns in the passage 35 and at times back into the Venturi passage 34 depending on the pressure and volume of the air and fuel delivered as when burning at high or low loads. The burning mixture discharges down into the venturi end of the heating element and there entrains further air, this construction providing double injection of air in addition to the primary mixture of air with the liquid fuel. The mixture continues to burn throughout the length of the heating element depending to some extent on the regulation for high and low heating. With this construc-

5

tion the inlet length 23 of the heating element is heated to the highest degree and the horizontal length 25 and the outlet length 27 are heated to lesser degrees depending on the heat dissipation to the surrounding salt or medium. Heat transfer from the heating element to the salt body is relatively high because the transfer is mainly by conduction and the construction provides relatively large surface area for this heat transfer.

It will be observed that when starting to heat the salt body from its normal solid condition the salt is initially heated in the area surrounding the heating element continuously from one end of the container to the other and from top to bottom proportional to the magnitude of the heat at the different stages in its passage through the long, hollow heating element. By providing the highest temperature in the vertical inlet length of the heating element the salt body will become liquified to varying depth into the container as indicated diagrammatically by the dotted line 57 in Figure 2. That is, the salt medium is liquified first in the upper levels surrounding the inlet length of the heating element and progressively downward and along the horizontal length. This produces an upward circulation of the liquid salt medium along the sides of the heating element 23 which spreads inwardly at the top of the bath. This circulation applies to a lesser degree at the opposite end of the container, the liquified salt flowing in opposite directions from the medial region and rising along the vertical heater elements 23 and 27 in a thermal flow. By reason of this application and distribution of heat the salt body may be brought to a liquid condition and to a predetermined temperature in a comparatively short time and without danger of deforming or breaking down the structure of the heating element when the burner is operating at high load as during the initial period. After the liquid bath has been brought to the desired temperature the fuel supply will be cut down to burn at a lower load. Under this condition combustion takes place substantially throughout the length of the heating element and in this connection it will be observed that the construction and arrangement provides double air injection so that a large air supply is obtained which promotes a high degree of combustion efficiency. It will also be observed that with this air entraining construction comparatively small power and blower equipment are required for producing this large air supply. My invention also contemplates the use of a gas burner in place of the liquid fuel burner.

In Figure 6 I have shown a modified form of the invention as applied to a salt container 58 of length and width radically different from the long, narrow container above described. Here the container is substantially square and I have provided a plurality of heating elements 59 and 61 similar to the heating element 22 above described and similarly heated except that each heating element is arranged with its burner at an end or side of the container opposite from the burner of the other heating element. As a consequence of this construction circulation of the liquified salt is produced in horizontal paths as well as vertical, thus, promoting better heat distribution and advantages resulting therefrom.

While I have shown several embodiments of my invention, it will be understood that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate

6

by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

I claim:

1. A combined burner and immersion heating unit comprising a hollow heating element adapted to be immersed in a medium to be heated except for the opposite inlet and outlet ends which are arranged to enter and leave the medium, the inlet end of the heating element being shaped to provide a Venturi passage having an inlet opening above said medium open to the atmosphere and a discharge opening above the level of said medium, said Venturi passage having opposed walls which converge downwardly from said inlet opening to a narrow passage and which diverge downwardly from said narrow passage, a burner for discharging a combustible mixture into said inlet end of the heating element including means for providing a mixture of fuel and air, means for delivering said mixture into said Venturi passage and to thereby cause entrainment of air to said mixture through the inlet end of said passage, said burner comprising a casting attached to the inlet end of the heating element and shaped to provide a fuel mixing passage having a Venturi inlet at its upper end and an outlet at its lower end discharging into the Venturi inlet of the heating element, and further shaped at its upper end to provide a support for a fuel and air mixing unit, a fuel and air mixing unit on said support constructed and arranged to discharge a mixture of fuel and air into the inlet end of the first mentioned Venturi passage and to entrain secondary air into said mixture at said inlet.

2. A combined burner and immersion heating unit comprising a hollow heating element of the immersion type having a Venturi inlet passage, said Venturi inlet passage having a top inlet opening open to the atmosphere and a bottom discharge opening discharging into the portion of said hollow heating element adjacent said Venturi inlet passage, said Venturi passage having opposed walls which converge downwardly from said inlet opening to a narrow passage and which diverge downwardly from said narrow passage into said portion of said hollow heating element, a mixing tube having a Venturi inlet portion and an outlet portion, means for connecting the outlet of said mixing tube directly to said Venturi inlet opening of said heating element, a liquid fuel and air mixer comprising a liquid fuel nozzle having a needle valve controlled jet orifice means for connecting the outlet of said liquid fuel and air mixer to the Venturi inlet portion of said mixing tube, a liquid fuel supply for delivering a liquid fuel under pressure to said needle valve controlled jet orifice, an air pressure source arranged for delivering air under pressure to said mixer through a plurality of orifices arranged in close proximity to said jet orifice, whereby said liquid fuel and air under pressure are mixed in said mixer and said mixture is discharged into the Venturi inlet portion of said mixing tube, the discharge entraining secondary air into said Venturi inlet portion so as to combine with the discharged mixture whereupon the combined mixture is caused to be burned in said mixing tube, the burning mixture discharging from said mixing tube into the Venturi inlet passage of said hollow heating element.

JOHN WALLERIUS.

(References on following page)

2,515,618

7

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
793,472	Thorbus	June 27, 1905
1,069,243	Fogler	Aug. 5, 1913
1,080,113	Von Kugelgen et al.	Dec. 2, 1913
1,702,731	Hymer	Feb. 19, 1929
2,047,471	Hepburn et al.	July 14, 1936

Number
2,204,051
2,375,840
2,424,765

8

Name	Date
Ritts et al.	June 11, 1940
Ekstrom	May 15, 1941
McCollum	July 29, 1947

FOREIGN PATENTS

Number	Country	Date
189,633	Great Britain	Dec. 7, 1922
655,117	Germany	Jan. 10, 1938

OTHER REFERENCES

"The Metal Industry," Apr. 9, 1937.