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[54] **METHOD AND DEVICE FOR HEATING OPEN MELTING BATHS, ESPECIALLY GALVANIZING BATHS, ENAMELING BATHS AND GLASS BATHS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **432/26;** 432/29; 432/195; 432/210

[51] **Int. Cl.** **F27b 14/00**

[58] **Field of Search** 432/8, 23, 26, 29, 156, 432/195, 210

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[57] **ABSTRACT**

A method of and device for heating open melting baths, e.g. galvanizing baths, enameling baths, glass baths and the like, according to which an inert gas is by means of pipes, passages, slots and the like introduced into the respective bath and is withdrawn above the pipes and the like when no articles are to be immersed into the bath for treatment therein, whereas, when articles are to be immersed into the bath for treatment therein, the inert gas is withdrawn outside the path of movement of such articles or outside a device for feeding and withdrawing additional substances into and out of the bath respectively.

20 Claims, 5 Drawing Figures

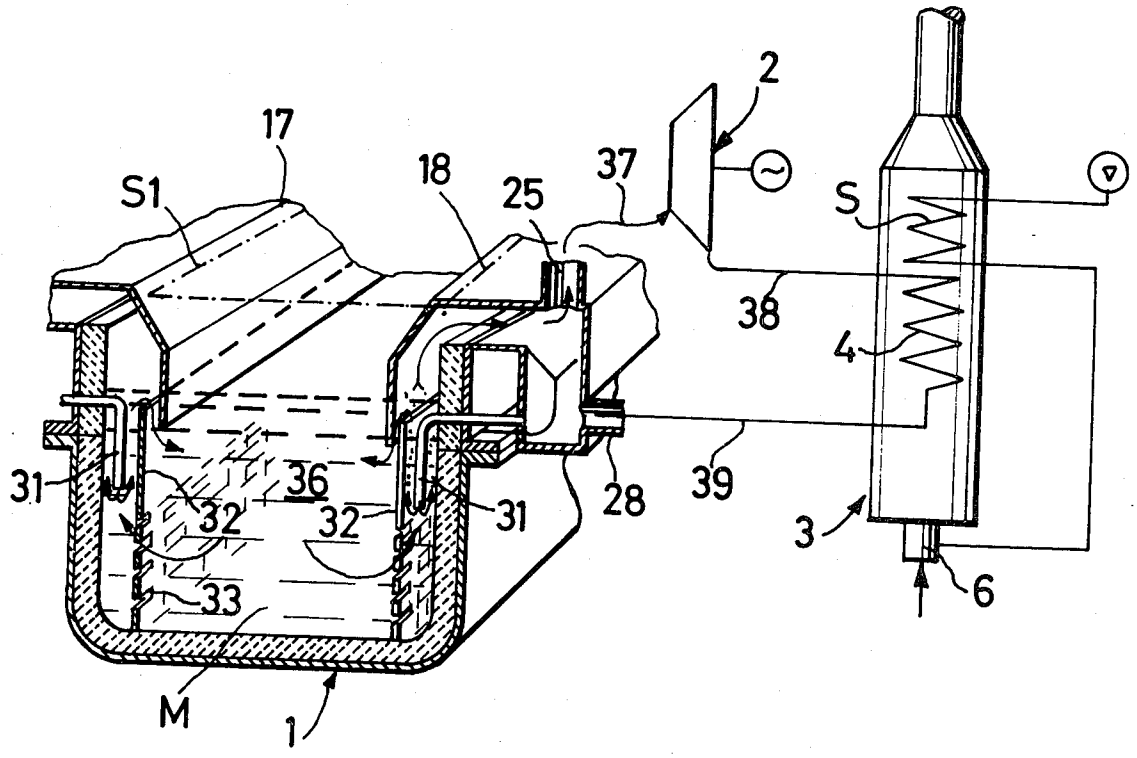

FIG.1

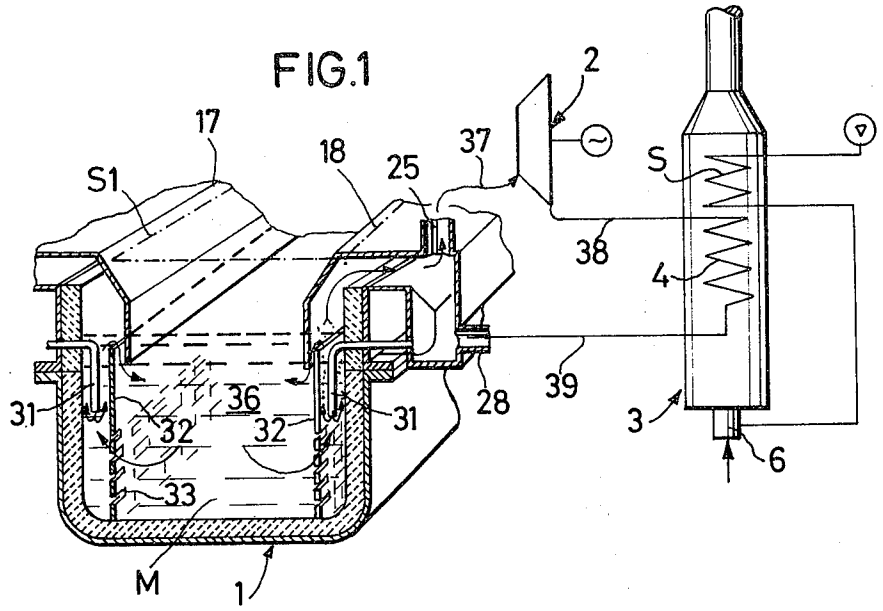
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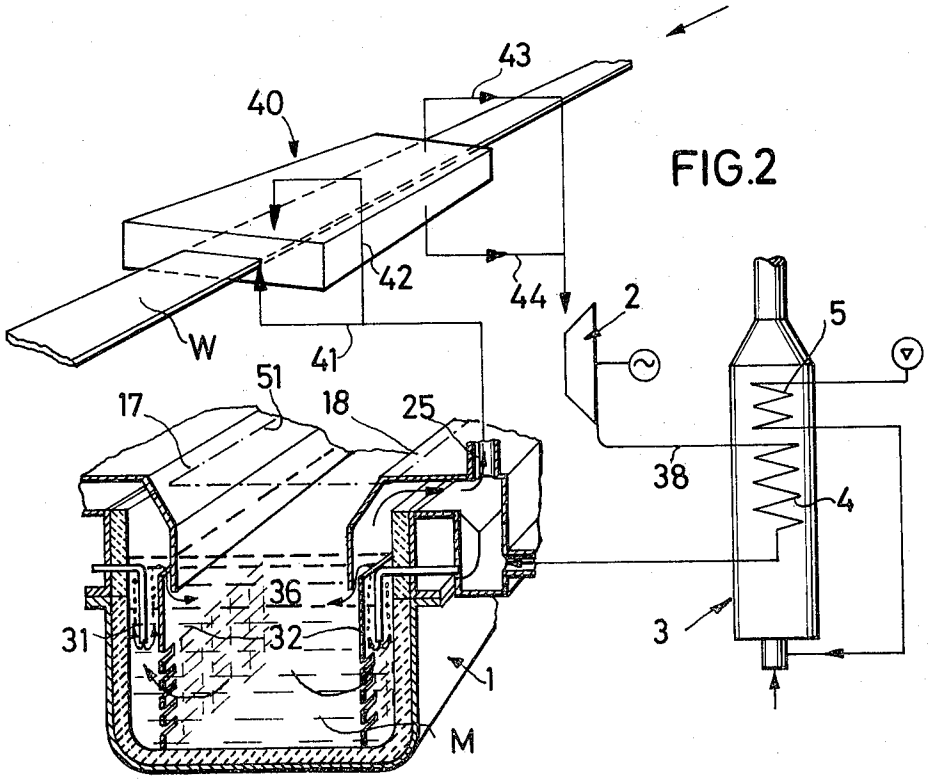
FIG.2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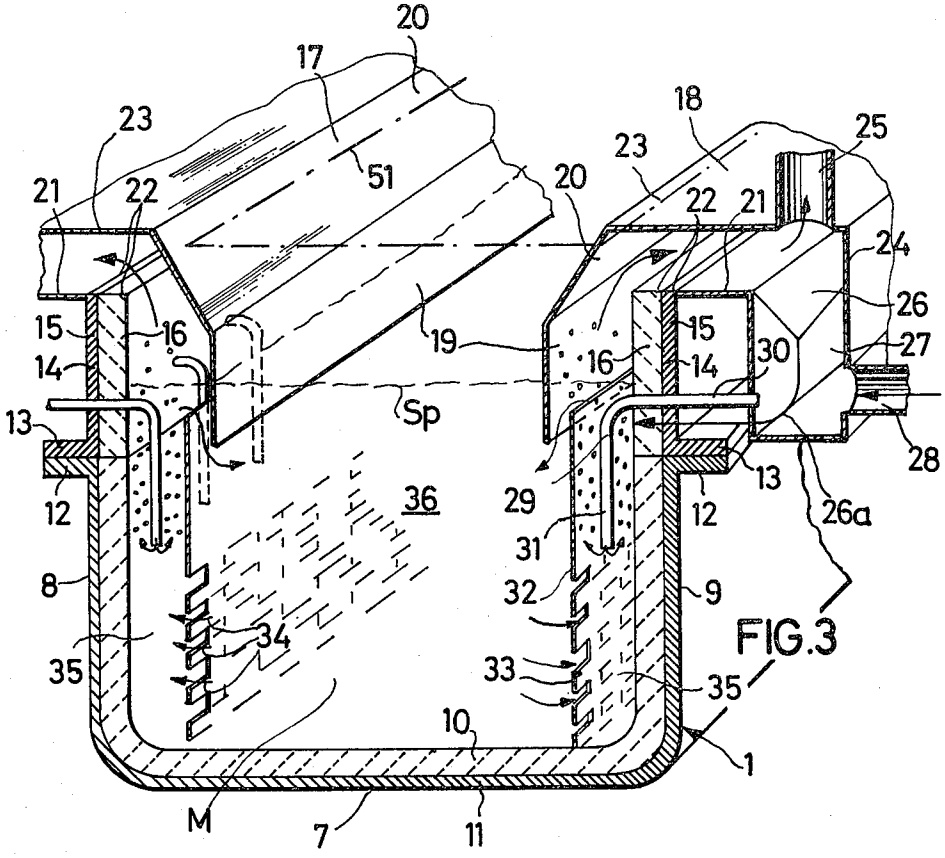


FIG.3

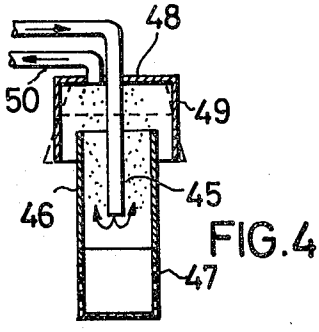
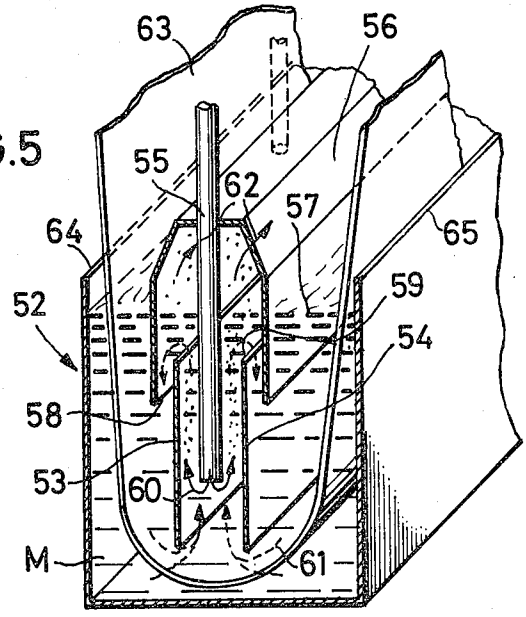


FIG.4

FIG.5



METHOD AND DEVICE FOR HEATING OPEN MELTING BATHS, ESPECIALLY GALVANIZING BATHS, ENAMELING BATHS AND GLASS BATHS

The present invention relates to a method of heating open melting baths such as galvanizing baths, enameling baths, lead coating baths, metallic baths, glass baths and the like in tubs and vats or tanks. The present invention comprises furthermore a device for practicing the above method and also relates to methods and devices according to which a heat is conveyed from the outside to an open bath of materials in order to bring about and maintain the heat condition of the bath. By "open melting baths" are meant such baths the container of which the tub or vat or tank is at least temporarily open for charging the bath material or for immersing of bodies or articles.

The heating of such baths has heretofore generally been effected by heating the outside of the respective container from the side thereof or from below by means of gas, oil or coal dust burners. Also an electric heating system was employed. According to the wall thickness and the material of the respective container, a considerable temperature drop occurred between the content, i.e., the bath and the burners or the heating means whereby the container or container wall was subjected to considerable temperature stresses.

In addition thereto, even with a favorable arrangement of the burners or the flue gas withdrawal or with a mixture with cooling air, a uniform heating was not possible. As a result thereof, damage by burning through tears or deformations occurred.

Therefore, it has been suggested to arrange the heating system above the container and cause the heat to act upon the surface of the bath. For glass melts this type of heating was suitable. With galvanizing, lead coating and enameling baths as well as with metal melt baths, however, in said last mentioned suggestion the effective depth of the heat energy from the surface was relatively minor aside from the interfering arrangement of the heating device above the respective container. In addition thereto, a considerable undesired formation of metal oxide was encountered due to the direct contact of the melt with the outer air while considering the heat action upon the surface of the bath.

A further drawback of heretofore known methods and devices for heating baths of materials in containers consists in that the waste gases leave the device with a temperature which exceeded by 100°C and more the lowermost temperature in the container so that the waste gas temperature in most instances amounted to more than 600°C. These waste gas losses greatly affect the economy of heretofore known methods and devices.

It is, therefore, an object of the present invention to provide a method of heating open melt baths of materials in containers in which a heating up of the bath may be effected in an economical manner and with a minimum of labor.

It is another object of this invention to provide a device as set forth above which will be simple in construction and in operation.

Still another object of this invention consists in the provision of a device as outlined in the preceding paragraphs which will make it possible to employ the invention with such baths into which bodies all articles of any type have to be immersed into the bath which means that a certain region within the bath must be free from pipes and conduits while a circulation of the bath melt must be assured.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

FIG. 1 illustrates a first embodiment of the device according to the invention in which the inert gas is from a shaft conveyed into a compressor and from the latter into a heater and from the heater to immerse tubes of the melting bath.

FIG. 2 shows another embodiment of the device according to the present invention in which between the shaft and the compressor there is interposed a treatment chamber for the material to be immersed into the bath or material which has already been treated.

FIG. 3 illustrates on a somewhat larger scale than FIGS. 1 and 2 the container with the immersion tubes.

FIGS. 4 and 5 illustrate additional examples of immersion tubes and gas withdrawal means.

The method according to the present invention is characterized primarily in that an inert gas is circulated through closed portions of the open bath and through a heater. According to an advantageous embodiment of the invention, the inert gas is by means of pipes, passages, slots or the like introduced into the bath and is withdrawn above said pipes, and with baths for treating bodies or articles to be immersed is withdrawn outside the path of movement of such body or article or outside an adding and withdrawing device.

According to a preferred embodiment of the method according to the invention, the inert gas is introduced into the bath symmetrically with regard to the longitudinal or transverse axis of the container and is symmetrically withdrawn.

According to a further development of the method according to the invention for baths into which a body or article is immersed, it is provided that the gas after leaving the bath is conveyed to the body or article to be treated in the bath or having been treated in the bath whereupon the gas is subsequently heated.

According to a still further development of the invention, the container is filled up to above the mouth of the pipes which introduce the gas into the bath and of the lower end of a withdrawal shaft of the container for the inert gas.

With a device for transferring the heat of a gas to a working medium of a heat consuming process, it has become known to pass a heat dispensing gas through the liquid metal bath. It has furthermore become known with a heat exchanger for cooling hot inert gases in a metal bath while generating steam, to introduce the hot inert gas through immersion pipes into the metal bath. It has also become known to convey a heat dispensing inert gas from a core reactor through a metal bath. Finally, it is also known to circulate an inert gas passed through a metal bath while providing a heater and a metal bath. With the heretofore known devices, the liquid metal serves exclusively as heat conveying means in a heat exchanger with closed container.

The invention suggests a solution which is fundamentally different from that referred to above. More specifically, according to the invention, the bath liquid or melt is not employed as heat transfer means to heat absorbing media but the inert gas is employed for directly heating an open treatment bath for instance a galvaniz-

ing bath, enameling bath, lead coating bath or the like. A so-called air lift pump causes the inert gas to bubble through the bath in the container whereby a circulation of the bath is brought about so that the withdrawal of the gas from the open bath can be effected in one portion of the bath which is located for instance with galvanizing baths, enameling baths and lead coating baths outside that section of the bath which receives the body or article to be treated. Without resorting to mechanical or other circulating means, all ranges of the bath are circulated without impediments by immersed bodies to be treated or by articles or feeding or withdrawing pipes.

The device according to the invention for practicing the method of the invention provides for instance in the gas circulating conduit behind the container a separator, a compressor or a heater. In this connection, in the gas conduit between that container receiving the bath and the compressor there may be provided an air preheater for the combustion air of the heater. According to a modification, in the conduit between the compressor and the heater or in the heater itself, and air preheater may be arranged. The first mentioned embodiment has the advantage that the gas which passes out of the container is cooled once more in the air preheater and is conveyed to the compressor at the lower temperature.

According to a further development of the invention, the container is at each longitudinal and/or transverse side provided with a plurality of pipes which convey the gas into the bath while above the pipes on the container rim there is provided a withdrawing draft flue having that vertical wall thereof which faces the interior of the container end above the mouth of said pipes. The pipes may in a manner known per se be designed as immersion pipes which are arranged in rows parallel to and near the side walls of the container. Advantageously, between the lower section of the vertical flue wall which faces the interior of the container, and the immersion pipe or mouth of the pipe there is provided a deviating wall. This deviating wall forces the gas introduced into the bath to maintain a rising movement in the vicinity of the container wall while the gas bubbles through the bath. The gas imparts upon the bath portion with the gas bubbles bubbling through a lower density so that this bath portion is above the gas exit from the pipes moved upwardly whereby a circulation of the contents of the bath is effected. If the gas, as is suggested, is introduced into the container at both longitudinal or transverse sides thereof, a continuous circulation of heated bath melt occurs at the walls of the container which means that the occurring lift pump effect will assure a circulation of the container content without mechanical means even around an immersed body or around immersed pipes.

The deviating wall preferably ends at a certain distance from the container between where it merges with a gate. The distance from the container bottom and the height of the grate depends on the immersing depths of the gas pipe and on the quantity and type of the bath melt.

In order to separate melt particles and condensed melt drops carried along by the gas current leaving the bath, the draft flue on each container side is connected to a separate leading into the feeding line into immersion pipes. Behind the draft flue there may be provided a separator for melt vapors (demister). In this way it will be avoided that the compressor and the pipes of the heater are attacked by harmful melt vapors and particles.

According to a further development of the invention, between the flue shaft of each container side and the compressor or the air preheater preceding said compressor there is arranged a gas type closed treatment chamber for the immersed bodies or articles or the bodies or articles to be immersed. These bodies may be such bodies which are continuously introduced into and withdrawn from the bath as for instance webs of material such as webs of sheet metal to be galvanized or bodies may be involved which are intermittently treated in conformity with an immersing method.

Referring now to the drawings in detail, the device for practicing the method according to the invention comprises primarily a container **1**, for instance a form of a tub or a vat or a tank, a compressor **2**, a heater **3**, and intermediate conduits between said parts. The heater **3** in addition to comprising a heat exchanger **4** also includes an air preheater **5** for the burner **6** of the heater. The container **1** illustrated in FIG. **1** serves with its content for galvanizing a web-shaped metal band. To this end the container **1** illustrated in FIGS. **1–3** comprises a lower part **7** with walls **8** and **9** and the bottom **10** and by way of example intended for galvanizing a web-shaped metal band. The walls and the bottom may be formed of two different material layers while the outer material layer **11** consists of metal and is provided with lateral flanges **12**. The inner layer on the other hand is as customary a ceramic layer.

The flanges **13** of a metallic part **14** pertaining to an upper structure **15** are connected to the flanges **12** of the outer layer of the lower part **7**. The upper structure **15** is provided with a ceramic lining **16**. The lower part **7** as well as the upper structures **15** form a container which is open at the top as is clearly shown in FIG. **3**, so that articles may be immersed or passed through this open area.

Laterally and above said upper structures **15**, passages **17, 18** are respectively arranged laterally and above said upper structures **15** and are extending along the longitudinal sides of the container. Each of said passages **17, 18** is toward the interior of the container defined by walls **19** and **20** and merges with a passage which is formed by the wall **21**, the end faces **22** of part **14** and the ceramic lining **16** as well as by the passage formed by the walls **23, 24** respectively. One or more conduits **25** lead into said passages **17, 18** which through a further common conduit **37** (FIG. **1**) are connected to the compressor **2**.

Adjacent the wall **24** and facing away from the interior of the container is a separator **26** which extends into a passage section **27**. The feeding lines **28** which together merge with the conduit **39** of the heater **3** lead into said passage section **27**. Immersing pipes **27** opposite said feeding lines **28** are attached to the channel section **27**. These pipes **29** have their horizontal section **30** extend through the upper structure **15**, whereas the vertical section **31** of each immersing pipe is near and parallel to the wall **8, 9** directed downwardly into the container **1**. The immersion pipes are arranged in such a way that they are from their entrance place into the container located below the customary metal bath level Sp in the container.

Parallel to the immersion pipes **29** which are located in series adjacent to each other, there is a partition or

deviating wall 32 arranged in said container. This wall 32 has its upper edge located approximately at the level of the horizontal section 30 of the immersion pipe 29 and thus below the level Sp of the metal bath M. The lower edge of the partition or deviating wall 32 ends somewhat below the lower and of the immersion pipe 29 which in its turn ends approximately at half the height of the depth of the melting bath.

The partitions or deviating walls 32 are near the bottom 7 of the container 1 continued in a grate 33 each so that as indicated by the arrows of flow in FIG. 3, melt bath parts flow in the direction of the arrow 34 through the grate 33 into the space 35 between the grate or partition and deviating wall 32 and the wall 8 or 9 of the container.

The inert gas which leaves the immersion pipes 29 at their lower end is shielded from the immersion area and bubbles through the melt in this chamber 35 outwardly and passes in the direction indicated by the arrow through the passages 17, 18 and the conduit 37 to the compressor 2.

The distance between the partition or deviating wall 32 and the grate 33 on one hand and the walls 8, 9 and 15, 16 on the other hand, the arrangement of the immersion pipes 29, the immersion depths of the pipes, the distance of the upper rim of the partitions or deviating walls 32, as well as the coordination of the walls 19 of passages 17 and 18 which with their lower edge extend below the level Sp of the melt bath M bring about a circulation of the metal bath while the central section 36 of the container remains free for a body to be treated or for the passage of the web to be treated.

According to the embodiment illustrated in FIG. 1, the cooled off compressed inert gas passes through a conduit 38 to the heat exchanger 4 from where it is conveyed through conduit 39 to the immersion pipes 29 to the horizontal section 30 of which there is parallely arranged a conduit 26 through which melted parts separated by the separator 26 are again returned to the bath.

Above the heat exchanger 4 there is arranged the air preheater 5 for the combustion air of the burner 6. The air preheater 5 may contrast thereto also be arranged in the conduit 37 whereby the inert bas leaving the passages 17, 18 will be cooled still further and in this condition is conveyed to the compressor 2.

According to the embodiment of FIG. 2, a treatment chamber 40 is provided in the gas-tight closed circuit of the inert gas between the conduits 25 and the compressor 2, conduits 41, 42 of the inert gas conveying the inert gas to both sides of a web W to be treated or to both sides of a web which has already been treated in the bath M of the container 1, thereby preheating and/or drying said web. The gas is withdrawn through conduits 43, 44 and conveyed to the compressor 2 which as a result thereof is acted upon with the cooler gas, that is the case with the embodiment of FIG. 1. According to the embodimen of FIG. 4, an individual immersion pipe 45 extends into a cylindrical partition or deviating wall 45 which is extended downwardly and ends in a grate 47. Above the wall 46 there is provided a pot-shaped hood 48 the vertical or inclined wall 49 of which as well as the upper rim of the partition or deviating wall 46 extends up to a point below the melting bath level. One or more withdrawing pipes 50 lead into the hood 48. The gas is withdrawn through pipes 50. The embodiment according to FIG. 4 is particularly well suited for belated mounting on already existing containers and has the advantage that it can be arranged on the container rim in any desired number at any desired place depending on the requirement.

The number of the immersion pipes 45 in each hood may be varied and the arrangement and number of the withdrawing pipes 15 may be changed.

For purposes of avoiding heat losses, the container 1 may for instance by a cover 51 be covered to such an extent that the web-shaped metal band can be passed into or out of the container. Similar remarks apply to the immersing of articles into the container 1. In this instance pivotable or removeably covers or flaps may be employed.

With the embodiment of FIG. 5, a container 52 is provided which has two parallel walls 53, 54 between which extends the immersion pipe 25. Above the walls 53, 54 there is placed a longitudinal hood 56 which the immersion pipe 55 is passed. The metal bath M has its level 57 extend up to the illustrated level above the lower edges 58 of hood 56 which as illustrated is located at a lower level than the upper edges 59 of walls 53, 54. The inert gas passes through the immersion pipe having associated therewith similar pipes extending in the longitudinal direction of hood 56. The inert gas passes through the immersion pipe in the direction of the arrow 60 into the metal bath and rises again between the walls 53, 54 through said metal bath while generating an air lift pump effect (see arrows 61) and pass into the longitudinal hood. From here the inert gas can be withdrawn through a pipe 62, can be heated up and in a circuit can again be conveyed to the immersion pipe 55. The band 63 may in the illustrated position be pulled through the bath. Also with the embodiment between the hood 55 and the walls 64, 65 of the container it is possible to provide a cover which will not interfere with the passing through to the band 63.

It is, of course, to be understood that the present invention is, by no means, limited to the specific showing in the drawings but also comprises any modifications within the scope of the appended claims.

What we claim is:

1. The method of treating an article in a heated liquid bath which comprises immersing said article in said bath in an open immersion area and heating the liquid by circulating an inert gas through a system closed to atmosphere, heating said gas and introducing said gas into said liquid below the surface spaced from said immersion area and collecting said gas passing upwardly through the surface of said liquid to continue circulation without exposure to air.

2. The method of treating an article as claimed in claim 1, in which said article is a web, which further comprises passing said web through a chamber and circulating said inert gas through said chamber to heat said web.

3. The method of treating an article as claimed in claim 1, which further comprises shielding said gas from said immersion area in said bath, to direct said gas upwardly to the surface and confine it to the closed system.

4. A method in combination to claim 1 for treating bodies and articles to be immersed in the bath, which includes the steps of: directing the gas after leaving the bath onto the article to be treated in the bath and subsequently heating said gas.

5. A method in combination according to claim 1 which includes the steps of: directing the gas after leaving the bath onto the article treated in the bath, and subsequently heating the inert gas.

6. A method in combination according to claim 1, which includes the step of filling the container up to a level above the mouth of the conduits and the lower end of a withdrawing passage means of the container for the inert gas.

7. A device for heating open melting baths, especially enameling baths, lead coating baths, metal baths, and glass baths, which includes: container means adapted to receive a melting bath, upright partition means arranged within said container means and at least partially defining gas receiving space means adapted at the upper and lower end portions thereof to communicate with the respective adjacent container space outside said gas receiving means, first conduit means leading into the upper portion of and downwardly in said gas receiving space means for conveying inert gas into said gas receiving space means, collector means arranged above said gas receiving space means for collecting gas ascending in said gas receiving space means, compressor means arranged outside said container means and communicating with said collector means for receiving collected gas therefrom and compressing same, heat exchanger means communicating with said compressor means for receiving said inert gas therefrom, and second conduit means establishing communication between said heat exchanger means and said first conduit means.

8. A device according to claim 7, which comprises a heater including said heat exchanger means and also including a burner and an air preheater for combustion air for said burner, and third conduit means leading from said compressor means to said heater and from the latter to said first conduit means.

9. A device according to claim 7, in which said first conduit means comprises a plurality of pipes for conveying inert gas into said gas receiving space, and in which said collector means includes a channel having at least one side wall overlapping the respective adjacent partition means while ending at a higher level than the lower end of said first conduit means.

10. A device according to claim 7, in which said first conduit means include immersion tubes arranged in rows substantially parallel to and near the side walls of said container means.

11. A device according to claim 10, in which said partition means includes a wall provided between the lower portion of said immersion tubes and that one wall of said channel of said collector means which faces toward the interior of said container means.

12. A device according to claim 11, in which said wall of said partition means ends above the lower edge of said one wall of said channel of said collector means which faces toward the interior of said container means.

13. A device according to claim 11, in which the lower portion of said partition means is an upright supporting grate.

14. A device according to claim 7, in which said partition means is spaced from the bottom of said container means.

15. A device according to claim 7, which includes separator means arranged on opposite container sides and communicating with said first conduit means.

16. A device according to claim 7, which includes conveying means interconnecting said collector means and said compressor means for conveying an inert gas therethrough, and a gas-tight treatment chamber arranged in said conveying means between said collector means and said compressor means for treating an article.

17. A device according to claim 8, which includes conveying means interconnecting said collector means and said air preheater, for conveying an inert gas therethrough and a gas-tight treatment chamber interposed in said conveying means for treating an article.

18. A device according to claim 7, in which said gas receiving space means include deviating cylinder means having a bottom and being open at the top and respectively surrounding the lower portions of said first conduit means in spaced relationship thereto, the open end of said cylinder means pointing upwardly.

19. A device according to claim 18, in which said collector means include hood means arranged above and in spaced relationship to the open end of said cylinder means, and also include gas withdrawing pipe means extending into said hood means.

20. A device according to claim 19, in which said cylinder means and said first conduit means and said hood means together form a plurality of substantially coaxially arranged structural units arranged on opposite sides of said container.

* * * * *