

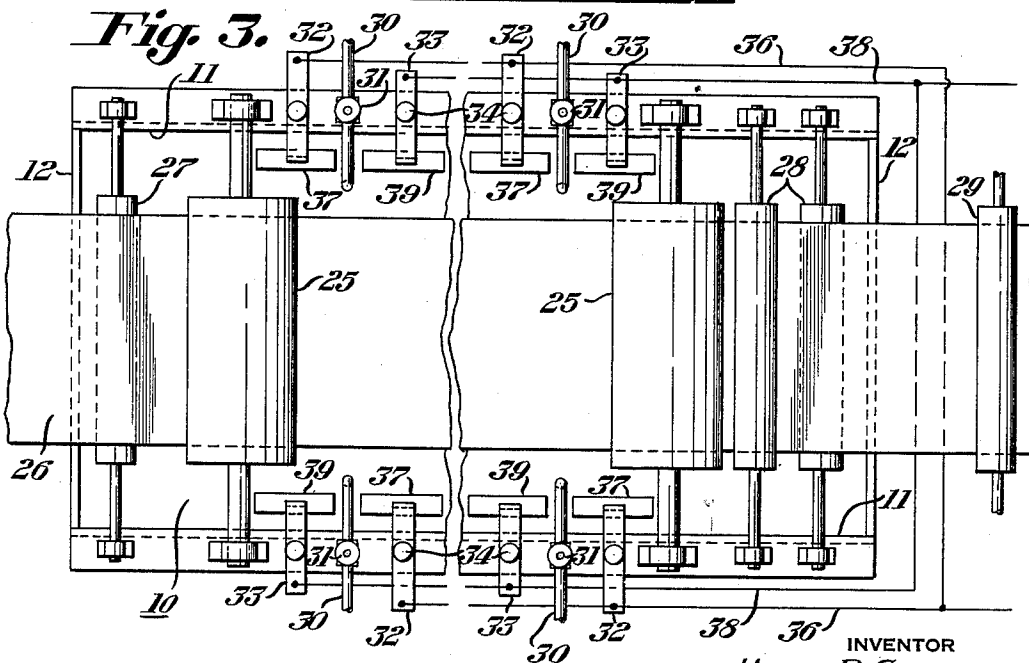
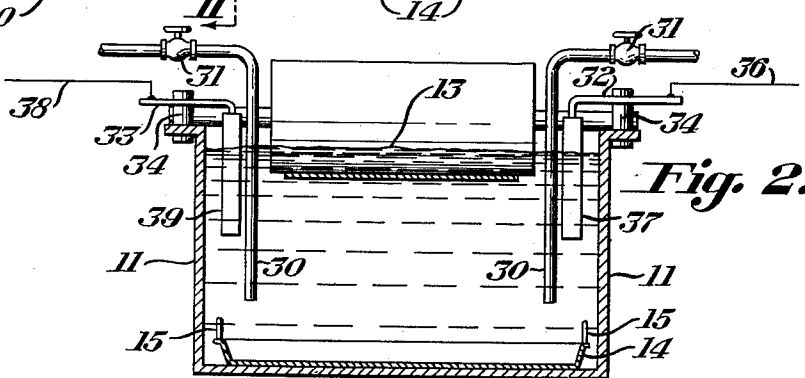
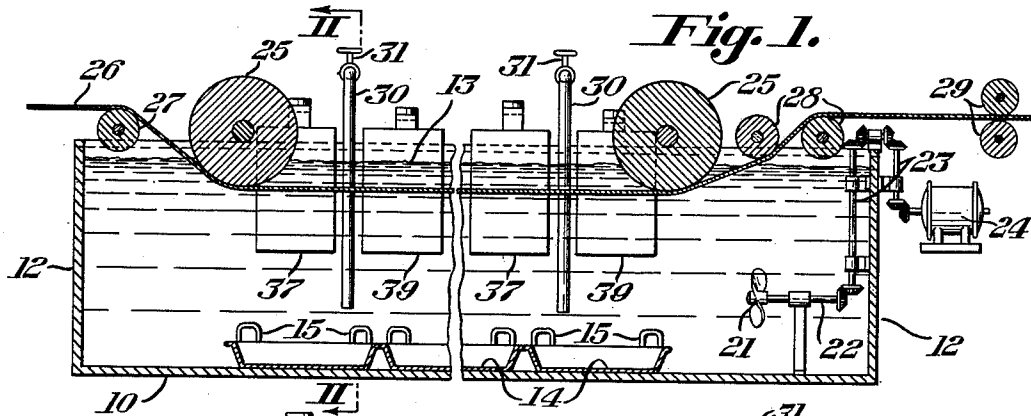
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SALT BATH SYSTEM AND METHOD FOR TREATING METALS

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SALT BATH SYSTEM AND METHOD FOR TREATING METALS

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This invention relates to a new bath system and method for treating metals and an universal alkaline salt composition for use therein in a fused state. More particularly, this new system comprehends electrolytic and non-electrolytic bath operations on ferrous and other metals using a new salt which is preponderantly caustic soda and which contains caustic potash and an alkaline earth metal halide. Still further, this new salt bath system enables such metals under selected conditions of operation to be cleaned, descaled, desanded and/or heat treated.

There are a number of processes which employ sodium hydroxide alone or with other ingredients purportedly to clean or descale ferrous and non-ferrous metals in non-electrolytic or electrolytic baths. In many cases, the compositions so used whether oxidizing or reducing in nature, relatively quickly become contaminated and render it difficult to produce clean work. Some salt compositions further require particular precautions to avoid undue build-up of an explosion potential or frequently can only be carried out at relatively low temperature or at low rates of effective activity. In other cases using prior salt compositions, the work treated is stained or left with an adherent coating, generally in the nature of an oxide, which is difficult to remove by conventional pickling methods. Examples of such prior practices are set forth in United States Patents Nos. Re. 22,887, 2,134,457, 2,261,744, 2,311,099, 2,353,026 and 2,458,660.

In the new system of this invention, the difficulties and objections encountered in the practice of the foregoing prior operations are overcome. Thus, I have produced a new salt composition for use in a fused state at temperatures generally in the range from about 650° F. to about 1350° F. That new composition may be employed in my new system under non-electrolytic or electrolytic conditions. In my operation, I find also that I may employ lower temperatures for cleaning or lighter deoxidizing and somewhat higher temperatures for descaling or desanding. In the upper portion of the temperature range, annealing or tempering of the work may also be achieved without any attack by the salt upon the base metal of the work in the course of its treatment by my new system. Generally, under electrolytic conditions, as distinguished from non-electrolytic operation, the temperatures employed will be relatively lower for descaling or desanding and I avoid non-uniformity of result or other difficulty by positioning the work between the electrodes without making it one of them. In addition to the prime quality of the work produced by it, my salt bath system, whether a non-electrolytic or an electrolytic operation, will resist oxidation and contamination and will retain its activity for greater periods of time for comparable tonnage treated. My new salt composition will also avoid becoming materially changed in the respective proportions of the ingredients in it.

Other objects and advantages will be apparent from the following description and from the drawings, which are schematic only, in which

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Figure 1 is an illustration in side elevation and partial section of one form of salt bath equipment, without the cover thereon, which may be used to practice my new system under electrolytic conditions;

Figure 2 is a section of the equipment shown in Figure 1 taken along line II—II thereof; and

Figure 3 is a plan view of the equipment shown in Figures 1 and 2.

My new composition consists essentially of caustic soda (NaOH), caustic potash (KOH) and an alkaline earth metal halide such as barium chloride (BaCl₂). My new composition may have the following respective proportions on a dry weight basis—NaOH, from about 70% to about 95%; KOH, from about 0.5% to about 12%; BaCl₂, from about 0.5% to about 20%. These ingredients of the new composition will generally be of a commercial grade of purity which, for example, in the case of sodium hydroxide usually includes from ½% to as much as 3% of sodium chloride by weight. For non-electrolytic applications, my new composition may have a range of the foregoing ingredients in the following proportions on a dry weight basis—NaOH, from about 85% to about 95%; KOH, from about 0.5% to about 4.5%; and BaCl₂, from about 0.5% to about 12%. A particular charge for use as a fused salt may have a composition for non-electrolytic operation of the following proportions on a dry weight basis—NaOH, about 95%; KOH about 4.5% and BaCl₂ about 0.5%. Similarly, for electrolytic applications, my new composition may have a range of proportions on a dry weight basis as follows—NaOH, from about 70% to about 98%; KOH, from about 0.5% to about 12%; and BaCl₂, from about 0.5% to about 20%. A particular charge for electrolytic operations may have a composition in following proportions on a dry weight basis—NaOH, about 98%; KOH, about 1.5%; and BaCl₂, about 0.5%.

In the operation of my new system, a temperature range may be availed of between from about 650° F. to about 1350° F., with a sufficient time of treating in each case to produce the result desired on the work. The number and type of work of metals and metal alloys that may be treated, the oxide, scale, sand, or other surface conditions thereof, comprise factors influencing in the treatment of the work by my new system the particular temperature and time relation to be employed. Temperature and time constitute conditions which to some extent may be interchangeable in the course of the employment of my new system as will be well understood by those skilled in the art. In general, cleaning off of grease, paint or lacquer coatings, enamel or dirt, for example, or the removal of lighter oxides from the surface of the work may employ a temperature from about 800° F. to about 900° F. in a non-electrolytic operation where no simultaneous annealing or tempering is to be sought. For the removal of heavier oxides or scale or for desanding castings, for example, a temperature range from about 800° F. to about 1050° F. may be utilized in non-electrolytic applications. Another non-electrolytic operation of my new system under the conditions recited will reclaim rusty iron, steel and other ferrous metal alloys such as those found in machine tools, nuts, bolts, shell cases and gun tubes to produce high quality scrap metal for remelting purposes. My new system will also remove all carbon in the form of graphite such as is sometimes found on the surface of the work such as cast iron castings. Higher temperatures within the broader range may also be employed without adversely affecting the base metal of the work. Temperatures between the melting point of the new composition, which usually will be in the neighborhood of 650° F. depending upon the respective proportions of the ingredients therein, and about 800° F. may be employed with a somewhat longer time

of treatment being accorded. In general, no temperature nor length of time of treatment will exceed that required to obtain the desired result on the surface of the work.

The time of the foregoing treatments may vary from a minimum of about 15 seconds to a maximum of about 2½ hours, during which the work will be immersed in and subjected to the action of my new salt while in a fused state in a suitable pot or container. The temperature of the fused composition in the container is generally maintained as relatively constant as possible by any of the various heating furnaces or other heating means available.

Heat treatment, tempering or annealing of the work may be accomplished in addition to cleaning, deoxidizing, descaling, and/or desanding. In the cases of such heat treatment utilizing a fused salt of my new system, the temperature range may be varied for the effect desired from about 1000° F. to about 1325° F. with a maximum temperature of about 1350° F. For example, spheroidizing may be obtained by my new system on ferrous plates or strips right from the hot rolling mills at a temperature in the neighborhood of 1250° F. in a treatment period of about one hour. Further, annealing will generally not exceed a treatment period of about one hour by my new system. Similarly, armor plate may be given a drawback treatment at a temperature of between from about 1050° F. to about 1250° F. for a relatively short length of time to develop the desired characteristics in the steel without impairing its other qualities.

The desanding of castings or the descaling of forgings with attendant heat treatment may be obtained in the approximate temperature range between from about 1050° F. to about 1250° F. for a sufficient time. In general, a treatment time between from about 15 seconds to about 2½ hours will be sufficient. For example, gray iron castings for automobile transmissions may be treated under non-electrolytic conditions in my new salt bath system at a temperature of about 1200° F. for about 4½ minutes during which time the metal is completely annealed, stress-relieved, desanded and descaled. The castings after being removed from the bath are air cooled for about 2 minutes, water quenched at room temperature and then given about a thirty second dip in 7% warm sulphuric acid. The acid dip may be followed by a hot water rinse and that in turn by a water soluble oil dip to protect the castings against atmospheric corrosion during storage. The same castings may be descaled and desanded in a non-electrolytic operation at a temperature from between about 850° F. to about 900° F. If steam is introduced into the new fused salt bath the sulphuric acid dip and water soluble oil dip may be omitted and the castings will be even lighter gray in color.

In the case of some metals such as stainless steel containing over about 11% chromium, stress relief can be obtained by bringing the material up to a stress relieving temperature without holding it at that temperature. Such, for example, is the case with stainless steel wire which has been cold worked. The stress introduced by the cold working can be removed in the fused salt bath in less than 15 seconds if it takes less time than that for the wire to reach bath's stress-relieving temperature. The longer periods of time such as 2½ hours would be those employed, for example, in batch as distinguished from continuous operations. In the descaling of hot rolled steel bands in a continuous operation by means of my new system, about thirty minutes would generally be the maximum time the bands might be maintained in a moving condition in the bath.

My new composition may also be used in a fused salt bath operating under electrolytic conditions. By way of illustration and not limitation, Figures 1 to 3 schematically illustrate a form of equipment usable for such purposes. Thus, a metal container or vessel 10 usually made of steel having vertical sides 11 and ends 12 may be filled to an appropriate level 13 with fused salt of my new composition. Foreign material which settles in the bath

in the course of the use thereof will fall into the pans 14 placed on the bottom of the pot 10. Thereby, the scale, sand, oxide, rust and/or other contaminant settling into the pans 14 can be removed periodically by removing the cover (not illustrated) of vessel 10 and lifting out the rolls before removing the pans 14 by means of crane hook slings engaging the eye-lugs 15 fastened to the edges of the pans 14.

Stirring of the fused salt bath may be obtained through the medium of an impeller 21 driven through shafts 22 and 23, universally coupled together. A motor 24 may be employed to turn shaft 23 and rotate impeller 21. Sinker rolls 25 may be journaled on the respective sides 11 of vessel 10 to define between them the level at which the work, such as ferrous strip 26, moves through the bath 13. Guide rolls 27 and 28 may also be employed and extend between the sides 11 of the vessel 10 where they are suitably journaled. The rolls 28 also tend to wipe off the surface of work 26 and reduce the amount of drag-out of salt from the bath 13. Pinch rollers 29 driven at a predetermined speed provide the motive power for moving work 26 through the fused salt in vessel 10 at a rate determining the selected time of immersion of work 26.

Steam or water injection pipes 30 may be provided extending downwardly inside vessel 10 below level 13 therein. Valves 31 are provided in respect to pipes 30 to regulate the flow of steam or water if any, which may be passed through the body of fused salt 13. If water is injected as may be done in a majority of cases, the valves 31 may be needle valves in the water line under sufficient pressure so that there can be no blow-back into the water line. The water issuing from the needle valves may be passed into a coil immersed in the fused salt bath to convert the water into steam which will blow into the bath itself in the controlled amounts desired. The converter coil will not be made of any electrodepositable metal such as copper whether the operation is under electrolytic or under non-electrolytic conditions. In place of injecting water or steam into the fused salt bath, hydrogen gas obtained from the cracking of ammonia, or natural gas, may be injected. A convenient test as to whether it may be desirable to inject any such substance may be obtained by dipping a piece of clean metal into the bath to determine whether or not it will be stained with the characteristic tan color of sodium oxide by such dipping.

Electrical conductor brackets 32 and 33 may be mounted in insulators 34 supported on the respective sides of vessel 10. The brackets 32 may be alternated along each side of and across vessel 10 with brackets 33. All the brackets 32 may be connected in parallel by a conductor wire 36 to a positive direct current source such as one from a motor-generator set or an A. C. rectifier. Anodic electrodes 37 are respectively suspended inside vessel 10 from each bracket 32 so that the lower portions thereof extend into the fused salt 13 on opposite sides of the work 26 as it passes between the sinker rolls 25. Similarly, the brackets 33 are connected in parallel by a conductor wire 38 to the negative pole of the direct current source. Cathodic electrodes 39 are suspended from each conductor bracket 33 and also extend into the fused salt 13 adjacent to and on opposite sides of the work 26. Work 26 never comes into contact with any electrode 37 or 39. If desired, the electrodes 37 and 39 may, instead of facing the edges of the work 26, be positioned horizontally above and below the work 26 within the body of fused salt 13. In general, the use in the equipment as aforesaid of any metal such as copper which may tend to electroplate out of the bath under any conditions is to be avoided.

In the operation of my new system under electrolytic conditions utilizing equipment, one form of which is illustrated in Figures 1 to 3, cleaning, deoxidizing, descaling, and/or desanding may quickly, conveniently and efficiently be performed. In general, the impressing of a

voltage across that portion of the bath of my new salt in fused condition surrounding the work between the sinker rolls 25 at the time being will generally enable my new system to be carried out at a somewhat lower temperature or in somewhat less time or with a combination of both such advantages. Moreover, the electrolytic phase of my new system can be employed with advantage in the treatment of work the surface of which is extremely heavily rusted, scaled or sanded. The action of my new composition in its fused state appears to be speeded up when electric current is flowing between the electrodes such as the respective electrodes 39 and 37 through that part at least of the work suspended or moving therebetween out of contact with any of those electrodes. For example, except in the case of simultaneous heat treating, my new bath system under electrolytic conditions will generally not be held at a temperature exceeding about 1150° F. Usually, a voltage across the respective electrodes 37 and 39 of from about 2 to about 30 volts and a current which may go as high as several hundred amperes from a minimum of about 20 amperes will suffice. While the operation illustrated in the figures has been described in connection with the use of direct current, it is also possible to operate satisfactorily while reversing the polarity of the current to obtain a corresponding reversal of current flow through the bath and the work in the bath.

In the electrolytic phase of operations utilizing my new system, a temperature range between from about 700° F. to about 800° F. will usually be sufficient to clean or to remove sand or oxides in the form of scale from the surface of ferrous and nonferrous work of metal. The time of such treatment may be varied from about 15 seconds to about 2½ hours, with satisfactory results in normal situations occurring in the course of a time of treatment extending between from about 15 seconds to about 20 minutes. Further, the increased activity of my new system under electrolytic conditions will enable the most adherent material on the surface of ferrous and nonferrous metals including titanium and its alloys to be substantially loosened and removed. Moreover, it appears that if the current is left in an electrolytic operation although there is at that time no work in the fused salt bath of my new composition, the introduction of the next lot of work may be processed relatively even more quickly in achieving the desired removal of scale, for example. Possibly, this even more heightened activity results from an increased rate of reduction of the scale because of the presence in the bath of a relatively larger amount of alkali metal which would seem to be composed almost entirely at least of the metal sodium.

In both non-electrolytic and electrolytic operations of my new system, there appears to be a reducing action or at least a suppression of any tendency of the fused salt in the bath to oxidize as well as a suppression of contamination therein or the undue formation or suspension of sludgy or solid contaminants and reaction products. Such seems to be the case whether sand is being removed from castings, or graphite or carbon, grease, dirt, enamel, paint or other material is being cleaned off metal surfaces, or whether descaling is being undertaken. Without being limited to my theory of operation, it appears that my new fused salt bath system may pick up some moisture from the air and that the alkali earth metal halide at least may also help to keep the bath in relatively clarified and stabilized condition. Such stabilization is indicated by the activity of the new fused salt remaining at satisfactory levels of operability.

In some cases, whether in an electrolytic or non-electrolytic operation, some water or steam may be admitted to the fused salt bath as through pipes 30 when valves 31 are opened. The moisture so picked up or added never even approaches any quantity sufficient to render the fused salt bath an aqueous one in character. The moisture seems to help prevent any undue formation or build-up, possibly

with the help of the halide present, of sodium oxide. I have also found that for some situations, as in the case of heavy scale or thick sand coatings, sodium fluoride (NaF) may be a beneficial addition ingredient in an amount by weight on a dry basis between from about 0.5% to about 5%. In those cases, the sodium fluoride addition appears to assist in the reducing and stabilizing action.

In my new system, there will be a relatively low drag-out loss because of the character of the new system even in the case of the continuous treatment of strip as distinguished from the batch treatment of castings, forgings or other individual pieces of work. Whenever the level of the salt bath in the containing pot or vessel begins to be appreciatively lowered after continued use, additional salt in a dry state and conforming to my new composition being used may be added directly to the bath to raise the level to the desired point. Because of the resistance of my new salt bath system to oxidation and contamination, treatment therein can be continued relatively speaking for longer periods and on greater tonnages than has heretofore been possible without adversely affecting the quality or quantity of the work produced. In the case of large tonnages or heavy pieces of work being treated at a single time, any tendency thereof to reduce the temperature of the fused salt bath as it is being immersed may be counteracted by preheating the work to the temperature of the salt bath.

The following illustrations of the manner in which my new salt bath system will work are not to be deemed limitations in or on the practice thereof. Thus, in using my new salt having an approximate composition, dry and by weight, of NaOH, 90%; KOH, 6%; and BaCl₂, 4%, under non-electrolytic conditions, will treat gray iron castings to clean, thoroughly desand and heat treat them when immersed in a fused bath of such salt for a period of about 5 minutes at a temperature of about 1225° F. Thereafter, the castings may be cooled in air for a short period, quenched in water, given a neutralizing rinse in dilute mineral acid such as sulfuric acid or hydrochloric acid, water rinsed, dried and given a soluble oil dip to prevent corrosion in storage.

Again, a fused bath having my new salt with an approximate composition on a dry weight basis of—NaOH, 88%; KOH, 6%; BaCl₂, 5%; and, with an addition ingredient in the form of, NaF, about 1%, will remove all trace of surface graphite from gray iron and alloy castings in less than 5 minutes when treated, under non-electrolytic conditions, between from about 850° F. to about 1150° F. Such treatment of the castings for about 4 minutes from about 1150° F. to about 1250° F. will further uniformly anneal such castings as well as clean them. Ordinary hot-rolled carbon steel treated off the hot mills at about 950° F. for about 2 minutes will be freed of oxides following which the steel may be water-quenched and dipped, for example, in dilute (e. g. 8%) sulfuric acid or muriatic acid for about 1 minute. Similarly, low chrome steels (4% to 6% Cr) treated for about 7 minutes at about 950° F. will be cleaned of heavy scale following which they generally will be water-quenched and dipped in dilute mineral acid at about 150° F. for about 2 minutes leaving a white unetched surface. The foregoing illustrations are also under non-electrolytic conditions.

As illustrations of possible electrolytic applications of my new system, a salt mixture having an approximate composition, on a dry weight basis of, —NaOH, about 92%; KOH, about 2% and BaCl₂, about 6%, will, when reversing the respective direct current anodes like electrodes 37 cathodes like electrodes 39 at one-minute intervals, remove scale from stainless steel work in about 5 minutes utilizing a temperature in the range between from about 750° F. to about 1000° F. Such treatment for about 10 minutes reversing the polarity of the electrodes midway through the treatment period will not only remove such scale but also leave a glossy finish on the work being treated. A temperature in the neighborhood of

950° F. in the fused salt bath of my new system under electrolytic conditions will generally be an optimum one whenever heat treating is not simultaneously intended to be achieved.

Another electrolytic application utilizing my new salt with the immediately foregoing approximate composition and with the admission of steam to the fused bath, will completely remove scale from stainless steel work in about 6 minutes at a temperature between from about 750° F. to about 1000° F., the polarity of the respective electrodes being reversed at the end of successive intervals such as 1 minute, 2 minutes; 1 minute and 2 minutes of operation respectively. A maximum of 10 minutes of such treatment will usually suffice in even the most difficult of removal problems. The immediately foregoing treatment by my new system may be followed by water quenching the work and then dipping it into dilute (e. g. 5%) sulfuric acid then into dilute nitric acid to which some hydrofluoric acid may be added. The after-treatments of the work after being subjected to my new salt bath system is a matter which will be well understood by those in the after-treatment art. My new treatment leaves the work in such condition that no unusual, protracted or unduly expensive after-treatments are required to leave the surface of work metallurgically neutral, clean and dry.

It will be clear that my new salt composition and treating system may be used in a variety of applications on a variety of types of metal work without departing from the scope hereof. Thus, in the reclaiming of metals, my system can be employed for the removal of grease, dirt, enamel, or frit, or to strip paint or lacquer from metal parts and surfaces. It may also be used for the removal of rust (Fe_2O_3), lead coatings, graphite, silicon, or carbon compounds and to prepare metal surfaces for subsequent galvanizing, tinning or other coating or treatment. In the case of castings my invention can be used to remove the sand therefrom and, if desired, at the same time to heat treat such casting. In the case of forgings, my new system can be used to remove scale therefrom and again, if desired, to anneal or otherwise heat treat the forgings. My invention will work substantially on all types of steels and alloys and in continuous strip or batch operations. The new composition and treating system set forth herein are not to be limited by the mere uses to which such may be applied, or by mere variations in the proportions of the ingredients; or by changes in the operating conditions under which the compositions are to be used; or the type of work treated, to the extent that such are within the spirit of this invention and the scope of the appended claims.

I claim:

1. In a salt bath system, a composition consisting essentially of, sodium hydroxide from about 70% to about 98%, potassium hydroxide from about 0.5% to about 12% and the balance substantially an alkaline earth metal halide.

2. In a salt bath system, a composition consisting essentially of, sodium hydroxide from about 70% to about 98%, potassium hydroxide from about 0.5% to about 12% and barium chloride from about 0.5% to about 20%.

3. In a salt bath system, a composition consisting essentially of, sodium hydroxide from about 85% to about 95%, potassium hydroxide from about 0.5% to about 4.5% and barium chloride from about 0.5% to about 12%, such salt to be used in a fused state under non-electrolytic conditions.

4. In a salt bath system, a composition consisting essentially of, sodium hydroxide, about 95%; potassium hydroxide, about 4.5%; and barium chloride, about 0.5%, such salt being adapted to be used in a fused state under non-electrolytic conditions.

5. In a salt bath system, a composition consisting essentially of, sodium hydroxide from about 70% to about 98%, potassium hydroxide from about 0.5% to about

12%, and barium chloride from about 0.5% to about 20%, such salt being adapted to be used in a fused state under electrolytic conditions.

6. In a salt bath system, a composition consisting essentially of, sodium hydroxide, about 98%; potassium hydroxide, about 1.5%; and barium chloride, about 0.5%, such salt being adapted to be used in a fused state under electrolytic conditions.

7. In a method for metal treatment by an anhydrous salt bath system, the steps comprising, immersing work of metal having a surface to be cleaned in a fused composition consisting essentially of sodium hydroxide as the preponderant ingredient, potassium hydroxide and an alkaline earth metal halide at a temperature between about 650° F. and about 1350° F. for a sufficient time to clean said surface.

8. In a method for metal treatment by an anhydrous salt bath system, the steps comprising, immersing work of metal having a surface to be cleaned of grease, dirt and lighter oxides in a fused composition consisting essentially of from about 70% to about 98% of sodium hydroxide as the preponderant ingredient, from 0.5% to 12% of potassium hydroxide and the balance substantially an alkaline earth metal halide at a temperature from about 800° F. to about 900° F. for a sufficient time to complete the cleaning of said surface.

9. In a method for metal treatment by an anhydrous salt bath system, the steps comprising, immersing work of metal having a surface to be descaled in a fused composition consisting essentially of from about 70% to about 98% of sodium hydroxide as the preponderant ingredient, from 0.5% to 12% of potassium hydroxide and the balance substantially an alkaline earth metal chloride at a temperature from about 900° F. to about 1050° F. for a sufficient time to descale said surface.

10. In a method for metal treatment by an anhydrous salt bath system, the steps comprising, immersing work of metal having a surface to be deoxidized in a fused composition consisting essentially of from about 70% to about 98% of sodium hydroxide as the preponderant ingredient, from 0.5% to 12% of potassium hydroxide and the balance substantially an alkaline earth metal chloride at a temperature from about 650° F. to about 1350° F. for a period of time from about 15 seconds to about 2½ hours until said surface is deoxidized.

11. In a method for metal treatment by an anhydrous salt bath system, the steps comprising, immersing work of metal to be heat treated and having a surface to be deoxidized in a fused composition consisting essentially of from about 70% to about 98% of sodium hydroxide as the preponderant ingredient, from 0.5% to 12% of potassium hydroxide and the balance substantially an alkaline earth metal halide at a temperature from about 1,000° F. to about 1300° F. for a sufficient time to deoxidize said surface and heat treat said work.

12. In a method for metal treatment by an anhydrous salt bath system, the steps comprising immersing castings and the like of metal having a surface to be desanded in a fused composition consisting essentially of from about 70% to about 98% of sodium hydroxide as the preponderant ingredient, from about 0.5% to 12% of potassium hydroxide and the balance substantially an alkaline earth metal halide at a temperature from about 900° F. to about 1350° F. for a sufficient time to desand said surface.

13. In a method for metal treatment by an anhydrous salt bath system, the steps comprising immersing work of metal having a surface to be cleaned in a fused salt bath consisting essentially of from about 70% to about 98% of sodium hydroxide as the preponderant ingredient, from about 0.5% to 12% of potassium hydroxide, 0.5% to 5.0% sodium fluoride, and barium chloride as the balance, at a temperature from about 650° to about 1350° F. for a sufficient time to clean said surface.

14. In a method for metal treatment by an anhydrous

salt bath system, the steps comprising, immersing work of metal having a surface to be cleaned in a fused composition consisting essentially of from about 70% to about 98% of sodium hydroxide as the preponderant ingredient, from about 0.5% to 12% of potassium hydroxide and the balance substantially an alkaline earth metal chloride at a temperature from about 650° F. to about 1350° F., introducing steam into said fused salt bath during said immersion and continuing said immersion for a time sufficient to clean said surface.

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