

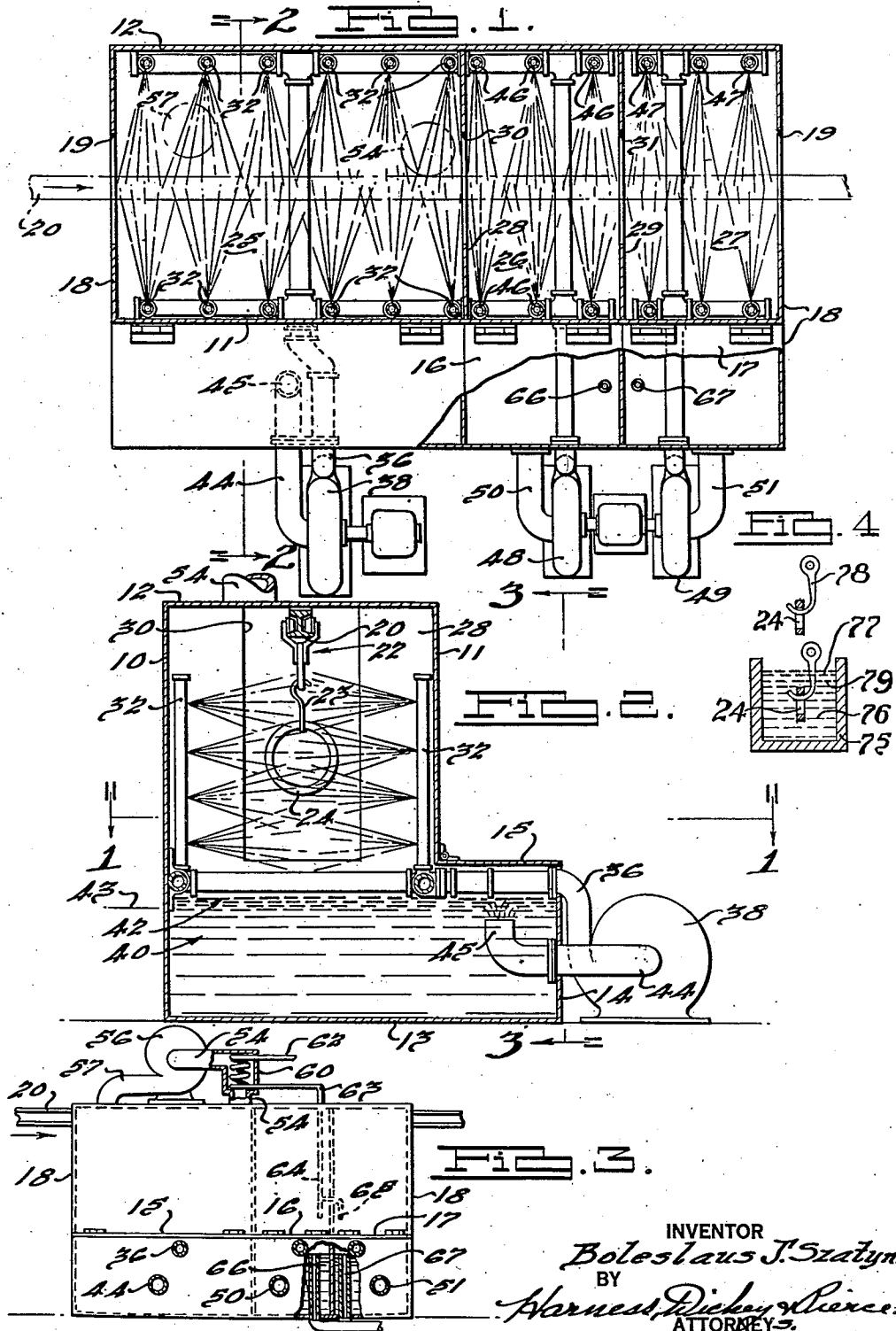
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CLEANING METHOD

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CLEANING METHOD

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6 Claims. (Cl. 134—26)

The present invention relates to cleaning processes and materials and particularly such as are applicable to the cleaning of metal parts in the process of manufacture in order to prepare their surfaces for such operations as plating, rust-proofing or painting. This invention constitutes an improvement upon one of the processes set forth in the application of Charles A. Campbell, Serial No. 347,929, filed July 27, 1940.

In the aforementioned application of Charles A. Campbell, there are disclosed materials, apparatus and methods for conducting cleaning operations on metal parts for the purpose of removing buffing and drawing compounds and other stubborn sticky, oily or greasy materials from metal parts in order to prepare the surfaces for plating, rust-proofing or painting. In accordance with the Campbell application, to which reference may be had for further details, the cleaning operation is carried on by the use of an unstable mixture of a cleaning solvent emulsion and an unemulsified cleaning solvent. This type of cleaning material is exceedingly effective, particularly in spray cleaning, but it is found that after a certain period of use when removing soil containing emulsifying agents there is a tendency of the unstable cleaning bath to form a stable emulsion which is much less effective as a cleaning agent. Accordingly, it is an object of the present invention to overcome this difficulty by maintaining the cleaning bath in an unstable form for a greater length of time than would otherwise be possible in order to prolong the period at which the cleaning bath has its maximum efficiency.

Another object of the present invention is to provide means for changing the form of the greasy or sticky materials removed from the work being cleaned to a form in which they will not adhere to work subsequently treated in the cleaning bath.

Another object of the invention is to provide means to cause the greasy, sticky and other constituents of the soil or dirt to not only change form but to leave the cleaning emulsion and float in the unemulsified cleaning solvent layer in order to facilitate removal of such dirt or soil from the solvent to the end that the solvent may be re-used.

Other objects and advantages of the invention will be come apparent from the following specification, the accompanying drawings, and the appended claims.

In the drawing:

Figure 1 shows a horizontal section, taken on the line 1—1 of Fig. 2, of a spray washing ma-

chine of a type adapted for use in carrying out the present invention;

Fig. 2 shows a vertical section in the same machine, taken on the line 2—2 of Figure 1;

Fig. 3 is a side view on a reduced scale taken on the line 3—3 of Fig. 2, parts being broken away to show a portion of the interior of the machine.

Fig. 4 is a view showing the manner in which the cleaning bath of the present invention is employed in dip cleaning.

The cleaning method of the present invention is preferably carried out by a spraying operation in which an unstable mechanical mixture of a cleaning solvent emulsion and an unemulsified cleaning solvent are sprayed upon the work to be cleaned. This unstable mixture is referred to throughout the specification as the "bath," or "cleaning bath." This bath is made up of a solvent emulsion containing any suitable cleaning solvent, water, and an emulsifying agent such as a soap. This portion of the bath, which is referred to throughout as the emulsion, is a stable solvent and water emulsion having the property of being able to clean by wetting action and dispersion. The cleaning bath, in addition to the cleaning emulsion, contains solvent in an amount greater than can be emulsified with the cleaning emulsion, with the result that the additional solvent remains separate from the emulsion and tends to float on the surface of the bath in a layer. This unemulsified solvent is normally, but not necessarily, the same as the solvent in the emulsion.

A machine suitable for carrying out the spray cleaning process is illustrated in the drawing. As there shown, the machine comprises a sheet metal casing of any desired construction having side walls 10 and 11, top wall 12, and bottom wall 13. The lower portion of the casing has a projection at one side defined by an auxiliary side wall 14 spaced outwardly from the wall 11 at the upper part of the machine on the same side. The offset between the walls 11 and 14 is closed by a plurality of hinged lids 15, 16 and 17. The ends of the machine are partially closed by end walls 18, which are entirely closed at their lower portions but have, at their upper central portions, openings 19 through which the work to be cleaned is passed.

Any desired means for conveying the work through the machine may be utilized, but, as shown in the drawing, it is preferred to utilize a chain type of conveyer which runs upon an I-beam track 20 extending entirely through the machine and the openings 19 in the end walls 18

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thereof. The chain conveyor, indicated generally at 22, is provided with a plurality of longitudinally spaced hooks 23 for supporting the work 24 to be cleaned.

The machine is divided into three compartments 25, 26, and 27. The compartment 25 is the washing compartment. Compartment 26, which is the first rinsing stage, is separated from compartment 25 by a wall 28. Compartment 26, in turn, is separated from compartment 27, the second rinsing stage, by means of a wall 29 similar to the wall 28. The walls 28 and 29 have openings 30 and 31 therein, which openings are similar to the openings 19 in the end walls 18. The lower portions of the compartments 25, 26 and 27, which are separated from each other by the lower portions of the walls 28 and 29, form reservoirs for retaining the washing fluid and rinse water, respectively. That is, the lower portion of the compartment 25 forms a reservoir for the washing fluid while the lower portions of compartments 26 and 27 form separate reservoirs for rinse water.

Mounted in the compartment 25 adjacent the side walls 11 and 12 are a plurality of vertically extending spray pipes 32 connected by suitable piping to the discharge outlet 36 of a pump 38. The vertically extending spray pipes are provided throughout their length with a plurality of spaced nozzles of any desired form, such as milled slots in the pipe, adapted to spray the cleaning material upon the work carried by the chain conveyor 22. It will be noted that the last spray pipes are positioned very close to the wall 28, with the result that the wall 28 forms a baffle acting to prevent the cleaning fluid from entering the first rinsing compartment.

The cleaning material which is discharged by the spray pipes 32 falls back into the reservoir in the bottom of the spray compartment 25 and means are provided for drawing the cleaning material from this reservoir and conducting it to the intake of the pump 38. It will be noted, as shown in Fig. 2 of the drawing, that the cleaning bath in the reservoir comprises an underlying body of emulsion indicated 40 upon the top of which is a layer 42 of unemulsified solvent. These two immiscible liquids have a distinct interface the level of which is indicated by the line 43 in Fig. 2. It is necessary, in order to properly conduct the washing operation, to draw into pump 38 a mixture of these two immiscible fluids, and this is accomplished in the machine illustrated in the drawing by connecting the pump intake 44 to a pipe 45, the open end of which extends vertically and lies just below the interface 43 of the two liquids. As a result of this arrangement, the pump suction draws in part upon the solvent layer 42 and in part from the underlying emulsion layer 40, thus drawing in a mechanical mixture of the two immiscible liquids. The action of the pump, as well as the turbulence created by the spray, renders this mechanical mixture an exceedingly intimate one, with the result that the free or unemulsified solvent is thoroughly dispersed through the spray.

Aside from the simplicity of this method of mixing the two layers, the method has the further advantage in that the relative proportions of the two liquids may be readily varied in any given installation by varying the distance between the top of pipe 45 and the interface 43, or, in other words, by adjusting the level of the interface. This may be done readily, since the system is a closed one, by varying the quantity and proportions of the cleaning bath in the reservoir.

The ratio of the amounts of the two liquids, which are drawn into the pump, is a function of the pump capacity, the intake pipe diameter, and the distance between the top of the pipe and the interface. These three factors may, of course, be adjusted to produce any desired ratio. Excellent results have been secured in an installation in which the pump capacity was 500 gallons per minute, the intake pipe diameter was four inches, and the distance between the top of the pipe and the interface was from four to six inches. It is, of course, necessary to make additions to the bath from time to time to compensate for evaporation loss and the material which adheres to the work which otherwise might vary the level of the interface.

The two rinsing stages 26 and 27 are identical and each comprises a plurality of vertical rinsing spray pipes 46 and 47, respectively, connected by suitable piping to the discharge side of individual pumps 48 and 49, respectively. The pump inlets 50 and 51 are connected directly to the rinse water reservoirs in the lower parts of compartments 26 and 27, so that the rinse water is re-circulated. Re-circulation of the rinse water is desirable not only because it results in a saving of water, but also a saving of heat since the water is sprayed at the preferred temperature of 120° F. It will be noted that the last washing sprays 32 are positioned quite close to the first rinsing sprays 46, being separated only by the wall or partition 28. This is desirable in order to avoid any drying off of the parts between the last washing spray and the first rinsing spray.

The cleaning bath in the reservoir of compartment 25, as well as the rinse water in the reservoir of compartments 26 and 27, is maintained at the desired temperature, preferably 120° F., by any suitable means such as thermostatically controlled steam coils, not shown, in the bottoms of the reservoirs.

In order to avoid contamination of the rinse water by the vapor from the washing spray and for the further purpose of preventing loss of cleaning material due to evaporation, there is provided a circulating and condensing system shown best in Fig. 3. As there shown, there is provided an air conduit 54 leading from the top of the machine casing at a point on the washing compartment side of partition 28, as shown in dotted lines in Fig. 1. The conduit 54 leads to the intake of a fan 56, which discharges into a conduit 57 leading back into the top of the casing at a point just inside of the entering end wall 18, also shown in dotted lines in Fig. 1. By withdrawing air and vapor from a point adjacent to but on the washing compartment side of the opening 30 in partition 28, a flow of air from the rinsing compartment into the washing compartment is created, which is effective to prevent entry of the vapor from the washing spray to the rinsing compartments. By leading the vapor and air back through the discharge conduit 57 into the opposite end of the washing compartment, any of the vapor which has condensed will be returned to the cleaning bath and a certain amount of the uncondensed vapor, if any, when coming in contact with the washing spray will likewise be condensed. A portion of the balance may flow outwardly through the opening 19 in the end wall 18, while the rest will flow towards the inlet pipe 54. By placing a condenser, shown more or less diagrammatically at 60, in the inlet pipe 54, it is possible to condense a greater portion of the vapors drawn into the pipe 54. As a result, loss of cleaning fluid is fur-

ther reduced. The form of condenser shown is of the water cooled type utilizing a source of water which enters the condenser from a pipe 62 and is discharged through pipe 63. It is preferable to constantly overflow the rinse tanks in order to remove any dirt or foreign material that may collect as a scum on the surface, and, therefore, it is advantageous to run the condensing water from pipe 63 directly into the rinse water reservoirs. This may be done in any desired manner, such as that indicated by the dotted line pipes 64 and 65 in Fig. 3. Suitable means, such as the two overflow pipes 66 and 67, may be provided to take the overflow from the rinse tanks. The particular arrangement and proportions of the washing machine are not critical as it is possible to utilize a longer machine or one which is arranged in general U-shape instead of being arranged in a straight line, and any desired number and arrangement of washing and rinsing sprays may be utilized.

While the solvent emulsion and the unemulsified solvent are intermixed in the spray, the fact that they are simply a mechanical mixture and not a stable emulsion enables the two constituents to act more or less independently, although simultaneously, upon the soil to be removed from the parts. The solvent in the spray has superior penetrating and wetting properties, with the result that it penetrated even the most heavily caked material and coats or wets the inert constituents. This coating or wetting by the solvent facilitates penetration, wetting and dispersing of the material by the emulsion. The emulsion, itself, has some penetrating and softening properties, and it disperses and carries the soil from the part being cleaned, even though that soil contains substantial quantities of inert material. In addition, the solvent tends to form a film between the emulsion and the metal surface which greatly facilitates rinsing.

In some cases, for example, where it is necessary to remove heavily caked buffing compounds from zinc die castings preparatory to electroplating, it is advisable to use both the dip and spray cleaning methods in succession. In this combination process, the parts to be cleaned are first dipped in a still bath containing the emulsion upon which is a layer of unemulsified solvent. This bath, as set forth in greater detail in the aforementioned Campbell application may be the same as the spray bath, except that it should contain less water. The dipping operation, as shown in Fig. 4, is carried on in an open tank 75 which contains the cleaning bath. The bath is made up of two layers; namely, the emulsion layer 76 and the solvent layer 77 overlying the emulsion with an interface 79 between the two. The work 24, which may be supported in any desired manner, as by hooks 78, is lowered into the bath entirely through the solvent layer and into the body of the emulsion and then withdrawn.

After the parts are dipped into this still bath, entirely through the solvent layer, they are then subject to a spray cleaning operation without any intermediate rinse. The spray cleaning operation should be conducted on the part before it has time to dry, although it is found that the cleaning emulsion from the dip bath tends to prevent or retard drying for a reasonable interval between the two washing operations, with the result that it is possible to have an intervening interval of several minutes.

When the cleaning bath of the aforementioned Campbell application is used for removing ordi-

nary buffing or drawing compounds, the material removed from the parts to be cleaned gradually contaminates the cleaning bath and reduces its efficiency. The most serious contamination is caused by the greasy or soapy constituents which find their way into the cleaning bath, since some of them act as emulsifying agents and gradually increase the capacity of the bath to emulsify the excess solvent. Accordingly, as the baths are used continuously the excess solvent which initially floats upon the bath in a separate clear layer is gradually emulsified with the cleaning emulsion beneath, and the free solvent layer reduces in amount until eventually it entirely disappears, all of the solvent having been emulsified with the cleaning emulsion. As soon as the bath becomes a complete stable emulsion, its cleaning efficiency is greatly reduced.

The period of time required for the cleaning bath to reach this completely emulsified stage depends upon the amount of cleaning which is done, the initial size of the bath, the proportion of solvent initially present, and the amount of soapy or emulsifying agents in the dirt or soil which is being removed from the parts to be cleaned. Under severe conditions, the bath may become completely emulsified in from four to eight hours. When this occurs, the bath should no longer be used.

In accordance with the present invention, the period during which the bath may be used at maximum efficiency is greatly prolonged, and other important advantages secured, by maintaining the cleaning emulsion in an acid condition and controlling the acidity within certain well-defined limits. Thus, in one case, when sufficient acid or acid reacting salt was added to the cleaning emulsion to maintain a pH in the order of 2.5 to 3.5, the useful life of the bath was increased from four to thirty-two hours.

Maintenance of an acid condition of the cleaning emulsion produces a number of important results. First, it prevents emulsification of the excess solvent by the emulsifying elements of the material removed from the work; second, it prevents a permanent colloidal dispersion of the dispersible elements of the soil in the cleaning emulsion which would load the emulsion and decrease its dispersing or cleaning power; and, third, it reacts with the dispersible substances to change them into a relatively hard, non-sticky form in which they will not adhere to the work, and in which they will not enter into objectionable reactions with the work. This change in consistency is apparently effected without causing the particles to drop or release the inert materials carried by or embedded in them. In addition, it is found that the small particles of dispersible material, which have been reacted upon by the acid, tend to float in the solvent layer and thus do not contaminate the cleaning emulsion. These particles are not affected by the solvent and hence do no harm, even though present in relatively large amounts. On the other hand, when the bath has served its useful life, the solvent layer may be drawn off and reclaimed in any suitable form of settling tank. The solvent is in relatively pure condition since, except for the relatively hard non-sticky particles which float in it and can be readily removed, by skimming or other mechanical separating methods, it contains only a relatively small quantity of completely dissolved oils or greases which were removed from the work.

The above described acid treatment cannot be

used in a dip washing method on chemically active metals, such as zinc die cast alloys, because of the fact that the acid in the cleaning emulsion will etch the metal parts in production. For some reason, not entirely understood, this etching may be eliminated in the spray washing method, even though an exceedingly chemically active metal, such as zinc, is being cleaned. Apparently, this is due to a blanketing of the metal by a film of unemulsified solvent in which there is no acid. At least, it is noted that if, under any given conditions, etching occurs in the acidified spray cleaning operation, it can be eliminated without changing the pH either by increasing the amount of solvent in the bath or by dipping the work either in pure solvent or the regular bath immediately before the spray cleaning operation, or by both of these expedients. In addition, temperature plays an important part in the tendency of the acid to attack the metal, and it is noted that there is much less likelihood of acid attack at the temperature of 120° F., which is preferred, than at higher temperatures.

Except for the acid strength, which is critical, the particular ingredients to be used in accordance with the cleaning method outlined may be widely varied, as may the proportions of the materials used. These variations depend in any particular case upon the nature of the cleaning operation to be carried on and other factors. As a general guide, a number of specific examples are hereafter given, along with an indication of the factors influencing the choice of constituents as well as the relative proportions of the various ingredients.

While, as previously indicated, the cleaning emulsion is a cleaning solvent and water emulsion formed by any suitable soap or other emulsifying agent, it is preferred to use as the emulsifying agent an amine soap formed from oleic acid, since such soaps have excellent wetting and penetrating properties and, in addition, are soluble in oils which, for reasons to be pointed out hereafter, is an advantage.

The solvent constituent of the solvent emulsion is preferably largely made up of the same solvent which forms the unemulsified solvent layer of the cleaning bath. Excellent results have been secured with a mineral spirit solvent falling between kerosene and naphtha in volatility, but any other cleaning solvent may be used. Other solvents which may be used include kerosene, naphtha, or any solvent that will dissolve oil and grease. It is apparent, also, that any desired combinations of solvents may be used.

It is preferred to use, in addition to the solvent, a smaller quantity of pine oil, since pine oil (steam distilled) has good wetting and penetrating properties and is an effective flotation agent which will assist flotation of the particles of acid reacted dispersible material.

In order to make available for sale and shipment a mixture of all of the ingredients (excepting water and acidifiers) necessary to carry on the process, it is preferred to combine the soap and solvent constituents, including oil, if any is present, in a clear stable solution, so that no settling or layering of the material will occur prior to use. It is partly for this reason that the use of an amine soap is preferred, since soaps of this type are soluble in hydrocarbon solvents and oils to a certain extent. In addition, if necessary, a suitable coupling or blending agent such as ethylene glycol monobutyl ether or cyclohexanol may be used to bring the soap and oil and solvent

constituents into a stable solution. The pine oil itself acts to a certain extent as a blending agent. It is obvious that various proportions and ingredients may be used, but, as an example, one satisfactory formula is as follows:

	Gallons
Triethanolamine -----	2
Oleic acid -----	4
Ethylene glycol monobutyl ether -----	2
Pine oil -----	15
Mineral spirits solvent -----	95

The above mixture of ingredients forms a clear amber solution which is permanently stable and which, therefore, is ready for addition to a suitable quantity of water for use at any time. It contains not only the solvent and emulsifying agent necessary to form the emulsion, but also the excess solvent necessary in the cleaning bath. It may be combined with any desired amount of water up to one part of solution to fifty parts of water, and when so combined with water becomes an unstable mixture of the cleaning emulsion and excess solvent. A certain percentage of the pine oil and mineral spirit solvent in the above mixture goes into the emulsion, but a substantial percentage of both of these ingredients simply remains on top of the bath as a clean unemulsified layer. The amount of solvent in the solution does not appear to be critical except that it must be more than the amount which will be emulsified by the emulsifying agent present. For example, it is found that the quantity of solvent may be doubled or the solution may be mixed with an equal quantity of reclaimed solvent without materially affecting the results secured.

The amount of water which should be added to the above solution depends upon the conditions and the type of cleaning operation being conducted. In the spray method, excellent results have been secured with thirty to forty parts of water to one part of either the above solution or a half and half mixture of that solution and reclaimed solvent. These proportions, however, do not appear to be very critical, except, as previously indicated, in the spray cleaning method it is generally necessary in any given case to adjust the proportions of water and solution in the cleaning spray by experiment in order to avoid etching of the metal when acid is used in the emulsion. In the case of the preliminary dip bath, previously mentioned, the above solution may be combined with as little as 4 parts of water to one of solution. No acid should be used in the dip bath because it is apt to attack the parts being cleaned.

So far as the acid treatment is concerned, it may be carried on by any water soluble acid or acid reacting salt capable of producing a solution or a cleaning emulsion having the desired pH. Among the inorganic acids which may be used successfully are sulphuric acid, phosphoric acid, pyrophosphoric acid and phosphorous acid. Nitric, hydrochloric and acetic acids cannot be used because they are too volatile and cause obnoxious or poisonous fumes at 120° F. Among the organic acids which may be used successfully are oxalic acid, maleic acid, monochloro acetic acid, dichloro acetic acid, bromo acetic acid, and phthalic acid. Formic acid cannot be used because it is too volatile at 120°, and trichloro acetic acid, which is otherwise satisfactory, is inconvenient to use because its hygroscopic character makes handling difficult. In addition to the

above acids, certain inorganic salts which ionize or hydrolyze to give an acid solution may also be used. For example, sodium bisulphate and potassium bisulphate, which ionize to give an acid solution, may be used satisfactorily to produce a cleaning emulsion having the desired pH. Aluminum sulphate, which both ionizes and then hydrolyzes to give an acid reaction, can be used, although when used alone will produce a minimum pH of only 3.5, which is not sufficiently low for most purposes. It is obvious, also, that mixtures of any of the above acids and/or salts may be used if desired.

The pH of the cleaning emulsion can be varied as desired to fit the requirements of the particular cleaning operation under consideration. It is found, for example, that in removing buffing compounds from zinc die castings a pH of 3.5 is sufficient to prevent emulsification of the bath, but that a greater acidity, namely, a pH of 2.0 to 3.3, is necessary to cause an acid reaction on the dispersible material in order to throw it out of the cleaning emulsion and render it non-sticky in character. In cleaning zinc die castings, any greater acidity (or lower pH) than a pH of 2.0 was found in a number of instances to result in etching and the production of an invisible film or surface condition on the metal that interfered with plating operations. It is sometimes necessary to employ a higher pH than 2.0 to avoid difficulty. The minimum and maximum pH for the solution when cleaning different metals and with various proportions of the cleaning bath may be readily determined by experiment in accordance with the foregoing principles. Likewise, the frequency with which acid additions to the bath must be made depends upon the conditions and must be determined by experiment. In one case in which zinc die castings were being treated to remove buffing compound, acid additions were made every four hours in amounts sufficient to bring the pH to about 2.5, with excellent results. In another, hourly additions sufficient to bring the acidity to a pH of about 2.5 produced even better results.

In the appended claims, the term "emulsion" is used to refer to a stable emulsion or colloidal suspension of water and some other immiscible liquid in the presence of an emulsifying agent such as a soap or the like. The term "solvent" is used to refer to cleaning solvent liquids adapted to dissolve greases and oils and other similar materials.

While several embodiments and examples of the present invention are given, it will be understood that changes may be made in the apparatus, methods, various ingredients and proportions without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. The method of cleaning metal parts for the purpose of removing matter containing emulsifying agents which comprises spraying the parts with a mechanically combined unstable mixture

of an emulsion of grease solvent and water and an unemulsified excess of said solvent, collecting, re-mixing, and re-circulating said mixture through the cleaning spray, and maintaining said emulsion in an acid condition.

2. The method of cleaning metal parts in the course of manufacture which comprises spraying the parts with a mechanically combined unstable mixture of an emulsion of grease solvent and water and an unemulsified excess of said cleaning solvent, collecting, re-mixing, and recirculating said mixture through the cleaning spray, and maintaining the pH of said emulsion approximately within the range of 2.0-3.5.

3. The method of removing buffing compounds from metal parts containing zinc in preparation for electroplating such parts which comprises dipping said parts into a grease solvent and thereafter spraying the parts with a mechanically combined unstable mixture of an emulsion of grease solvent and water and an unemulsified excess of said solvent, collecting, re-mixing, and re-circulating said mixture through the cleaning spray, and maintaining the pH of said emulsion at a point within the range of approximately 2.0 to 3.5.

4. The method of removing buffing compounds from metal parts containing zinc in preparation for electroplating such parts which comprises dipping said parts into an emulsion of grease solvent and water and thereafter spraying the parts with a mechanically combined unstable mixture of an emulsion of grease solvent and water and an unemulsified excess of said solvent, collecting, re-mixing, and re-circulating said mixture through the cleaning spray, and maintaining the pH of said emulsion at a point within the range of approximately 2.0 to 3.5.

5. The method of removing buffing compounds from metal parts containing zinc in preparation for electroplating such parts which comprises dipping said parts into an unstable mixture of an emulsion of grease solvent and water and an unemulsified solvent until the parts are entirely within the body of emulsion underlying the top solvent layer, withdrawing said parts and thereafter spraying the parts with a mechanically combined unstable mixture of an emulsion of grease solvent and water and an unemulsified excess of said solvent, collecting, re-mixing, and re-circulating said mixture through the cleaning spray, and maintaining the pH of said emulsion at a point within the range of approximately 2.0 to 3.5.

6. The method of cleaning metal articles which comprises spraying the articles with a mechanically combined unstable mixture of an unemulsified grease solvent which is of less density than water and an emulsion of grease solvent in water, collecting, remixing and recirculating said mixture through the cleaning spray, and maintaining the pH of said emulsion approximately within the range of 2.0 and 3.5.

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