

UNITED STATES PATENT OFFICE

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ELECTROCHEMICAL PROCESS FOR CLEANING METAL

No Drawing.

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It is among the prime objects of the present invention to provide an efficient and economical electro-chemical method for removing non-metallic foreign matter from metal surfaces and it is particularly concerned with a method for removing both saponifiable and non-saponifiable oils, greases, waxes and dirt such as paints, carbon smuts or the like. Throughout the following specification such foreign matter and occluded material is referred to as dirt and this term may be understood to be a generic term implying all surface matter other than metallic scale and oxides.

A specific object of the invention is to provide a dirt removing process which utilizes the phenomenon of throwing power whereby the concentration of the cleaning action will be shifted from point to point upon the area of work, thereby insuring the complete effective and efficient cleaning of deeply recessed or intricate surfaces.

Another important object of the invention is to provide a process in which the dirt removal is assisted by the action of metallic soaps which will tend to saponify or emulsify the dirt.

A further object is to provide a process in which detergent action, either by saponification or emulsification is assisted by the mechanical action of the liberation of gases at the work surface, which gases tend to disrupt or lift off particles of the dirt.

A further object is to provide a process which may be used either as a direct or reverse electro-cleaner as occasion demands; by merely changing the direction of the current in the electro-cleaning cell. This object is coupled with a further object which is to provide such a process by the use of a very simple inexpensive and stable electrolyte which does not contain the usual complex cyanides.

From the foregoing, it will be seen that the objects of the invention embrace the general desiderata of existing electrolytic dirt removing processes and in addition thereto provides a process incorporating novel and beneficial mechanical and chemical reactions which result in a cheaper, faster and more

thorough process for the removal of non-metallic surface foreign matter.

Generally stated, the process consists in subjecting the work to electrolytic action in a simple non-cyanide alkaline bath in the presence of metallic ions. The work may be made either anode or cathode and in either instance, the dirt is subjected to three distinct cleaning actions, namely: the chemical detergent effect of the alkaline solution; the saponification and emulsification effect and thirdly the mechanical action resulting from the liberation of gases at the work surface.

As one specific illustration of a commercially successful embodiment of the invention, I prefer to use an alkaline electrolyte made up of the following ingredients:

1 gallon water

4 oz. tri-sodium phosphate—

 $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ 12 oz. sodium hydroxide— NaOH

Obviously, the electrolyte may be widely varied as to the proportion of ingredients and, obviously, equivalents may be substituted. The electrolyte is preferably maintained at a temperature in the neighborhood of the 200° F. although the process may be operated over a wide range of temperatures.

The metallic content of the bath may be supplied through the inclusion therein of salts of a metal. While the metallic ion concentration may thus be inaugurated and maintained by the addition to the electrolyte of metal salts such as salts of lead, tin, zinc, or cadmium, I prefer for the purpose of economy and control, to introduce the ions by anodic action on electrodes thereof. When the process is used direct, anodes of such metal may be used and they will therefore corrode and give the desired ions to the solution. When the process is used reversed, a temporary anode of the desired metal may be used to initially introduce the ions. By using cathodes of the desired metal, the rest periods of the process will permit them to corrode and thus replenish the metal ion concentration.

The active metallic content of the electrolyte may be selected in accordance with spe-

cific requirement. Certain of the metals suggested will have characteristic advantages or disadvantages. In the case of lead, the process partakes of the benefit derived from the characteristic lead peroxide formed at the anode. With tin, metastannic acid is formed. It is, however, to be distinctly understood that the invention is not confined to the use of any specific metal such as lead or tin.

A current density of 60 amperes per square foot may be successfully used on a commercial basis. The process, however, will function successfully at current densities ranging from 10 amperes per square foot to 150 amperes per square foot.

When the work to be cleaned is made cathode, the cleaner is said, in the vernacular of the trade, to be a direct electric cleaner. When so operated, hydrogen gas is liberated at the cathode and assists in disrupting the grease film and in addition to such disruption, it will tend to crowd off and eliminate scaly particles of the dirt. The removal of saponifiable greases will be aided by chemical attack by the caustic constituents of the bath. Emulsification of the dirt may take place due to either the soap generated through the alkaline reaction at the cathode or else through the intentional addition to the bath of small quantities of soap. Where the dirt contains saponifiable elements, the bath will build up in soap content, but such building up is not objectionable since the emulsification will still take place even though the concentration of soap in the electrolyte becomes quite high.

As the dirt is removed by either mechanical action, chemical combination, emulsification, or saponification or combinations thereof, a thin metal film formed by the active metallic ions such as lead, in the case where lead ions are in the solution, is electro-deposited directly on the cleaned surface of the metal. Since the cleaned work surface provides the path of least electrical resistance, a thin, adherent, non-porous film of the metal, such as lead, will selectively deposit over such cleaned areas. Such deposit of metal immediately gives rise to the phenomenon of throwing power. The back pressure or counter-electromotive force set up in the electrolyte due to the hydrogen over-voltage of the metal film deposited causes the current density to shift from the area upon which such metal is deposited and as a consequence thereof, current densities are increased over adjacent cleaned or uncleaned area. Such automatic shifting of current densities increases the average cleaning speed of the bath and insures a concentration of current densities at distant, recessed or more heavily coated areas. Accidentally prolonged treatment does not lead to the building of a solid metal plate such as is obtained in electro-plating in the presence of

cyanides since, under conditions described, there is deposited over the microscopic film, a loosely adherent spongy deposit which may be readily rinsed or brushed from the work. The initial film of metal is in many cases highly advantageous, but if desired, it may be readily stripped from the work in various ways including the use of the process described in my Patent No. 1,867,527.

When the work is made anode, the process is operated as a so-called reversed electric cleaner. For example, in the case of lead ions in solution, sodium plumbate (Na_2PbO_3) is formed, and the exposure of the anodic work area from which the dirt is to be removed leads to a concentration of plumbate ions at the surface thereof. These ions, in turn, are discharged as lead peroxide (PbO_2), or complex lead peroxide phosphate. The finely divided lead peroxide formed, materially assists or catalyzes the oxidation of the grease or oil or dirt film, one of the end products being CO_2 , which in turn assists the oxygen in the mechanical detachment of dirt particles by adding to the gas volume at the work surface. The evolution of oxygen also has the mechanical effect of disrupting and lifting the dirt, as is the effect of the hydrogen when the work is made cathode. The CO_2 gas evolved performs a further very important service: it brings anodic throwing power into play by increasing the anodic polarization. The current density shifts from the points at which the CO_2 is being evolved to points still covered with grease or dirt.

The anodic reaction of the phosphate, when the work to be cleaned is made anode is the formation of an insoluble phosphate film over the cleaned surface. This film not only protects the metal underneath from electrolytic attack, but also furthers the anodic throwing power, oxygen being evolved at relatively high potential at phosphate covered points. The lead also provides another distinct advantage in that it tends to form a series of soluble lead soaps in the presence of oleic or stearic or similar fatty acids. The soaps act to detergently eliminate the dirt film.

For the reasons just stated, it is quite evident that the complex action of the lead salt is valuable in the degreasing action, and that it accounts for the marked difference in behavior of my bath from that of the ordinary electric cleaner run reversed where no definite and deliberate use is made of the peculiarities of lead for the purposes described.

Throughout the above description, it will be understood that I have attempted for the sake of clarity to set forth, in so far as possible, the probable chemical and electrochemical reactions involved. It will, of course, be understood that the reactions are complex and not easily nor fully understood.

The invention is, therefore, not limited to nor bound by the theoretical explanation here attempted by way of explanation.

Thus having described my process together with the most probable interpretation of the reactions involved, what I claim is:

1. A process for removing organic dirt from metallic parts which consists in subjecting the parts as anodes to electrolytic action in an alkaline electrolyte containing metallic ions which combine with oil or grease in the dirt to form a metallic soap.

2. A process for removing organic dirt from metallic parts which consists in subjecting the parts as anodes to electrolytic action in an alkaline electrolyte containing metallic ions of the group including lead, tin, zinc and cadmium which combine with oil or grease in the dirt to form a metallic soap.

3. A process for removing organic dirt from metallic parts which consists in subjecting the parts as anodes to electrolytic action in an alkaline electrolyte containing phosphate and metallic ions which combine with oil or grease in the dirt to form a metallic soap.

4. A process for removing organic dirt from metallic parts which consists in subjecting the parts as anodes to electrolytic action in an alkaline electrolyte containing phosphate and metallic ions of the group including lead, tin, zinc and cadmium which combine with oil or grease in the dirt to form a metallic soap.

Signed at Bridgeport in the county of Fairfield and State of Connecticut this 25 day of July A. D. 1932.

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