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(54) **Cleaning of chemically treated articles**

(57) As the final step of a chemical treatment operation, a treated article is rinsed with a rinse liquor to remove the chemical treatment liquid. The rinse liquor and said liquid are immiscible and are separately collectable; this permits recovery of valuable chemical treatment materials and re-use of cleaning liquids.

A chlorinated hydrocarbon (low-volatility or high-volatility) can be used, preferably supplemented by a

surfactant.

An ultrasonic transducer may be used (particularly where the treated article is rinsed by being immersed in a bath) to assist in the removal of the chemical treatment liquid from the article, said transducer being submerged in said bath.

The rinse liquor is preferably heated to its boiling point and the method is carried into effect in apparatus which includes a cooling device which condenses the vapour phase of the liquor and which promotes drying of the cleaned article.

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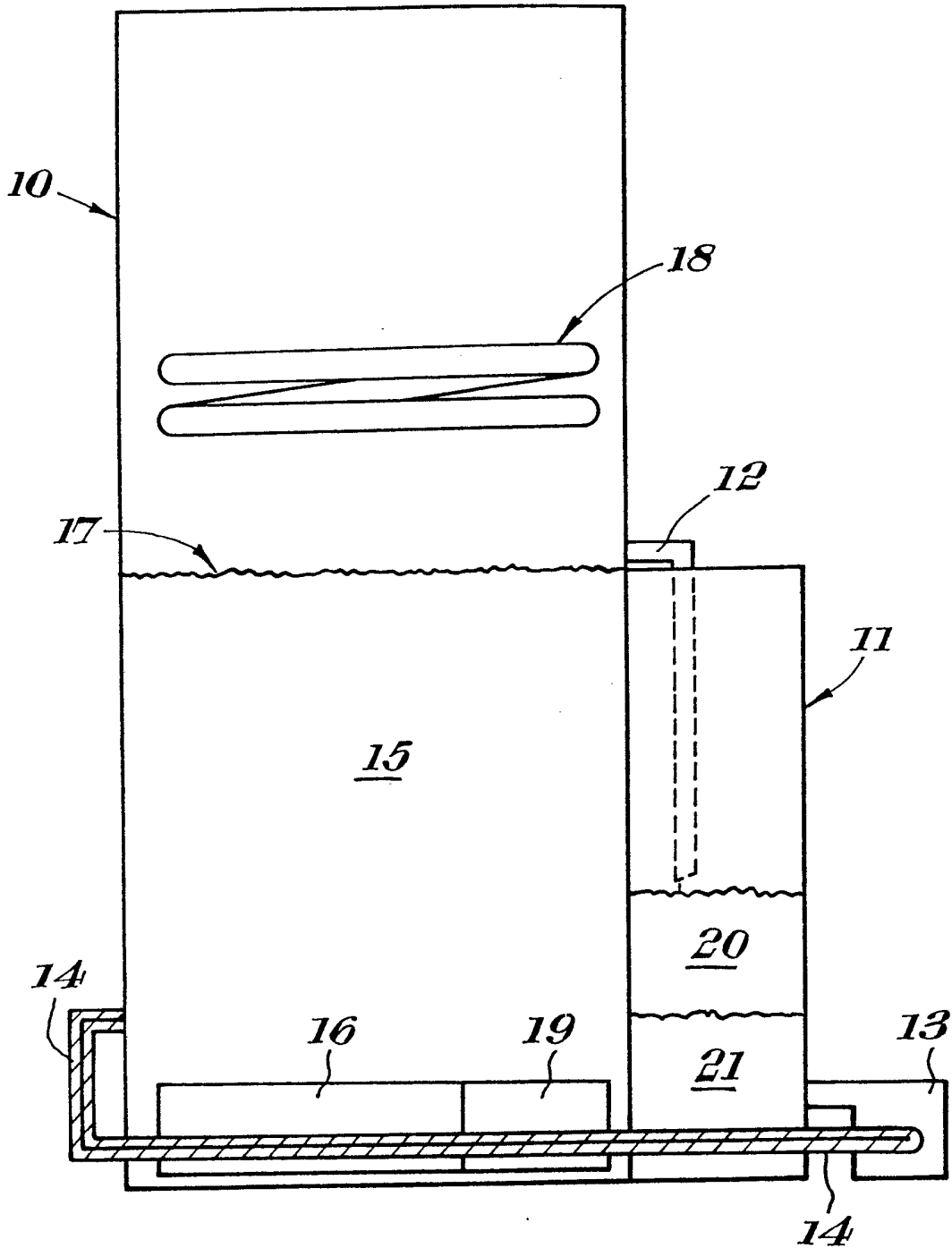
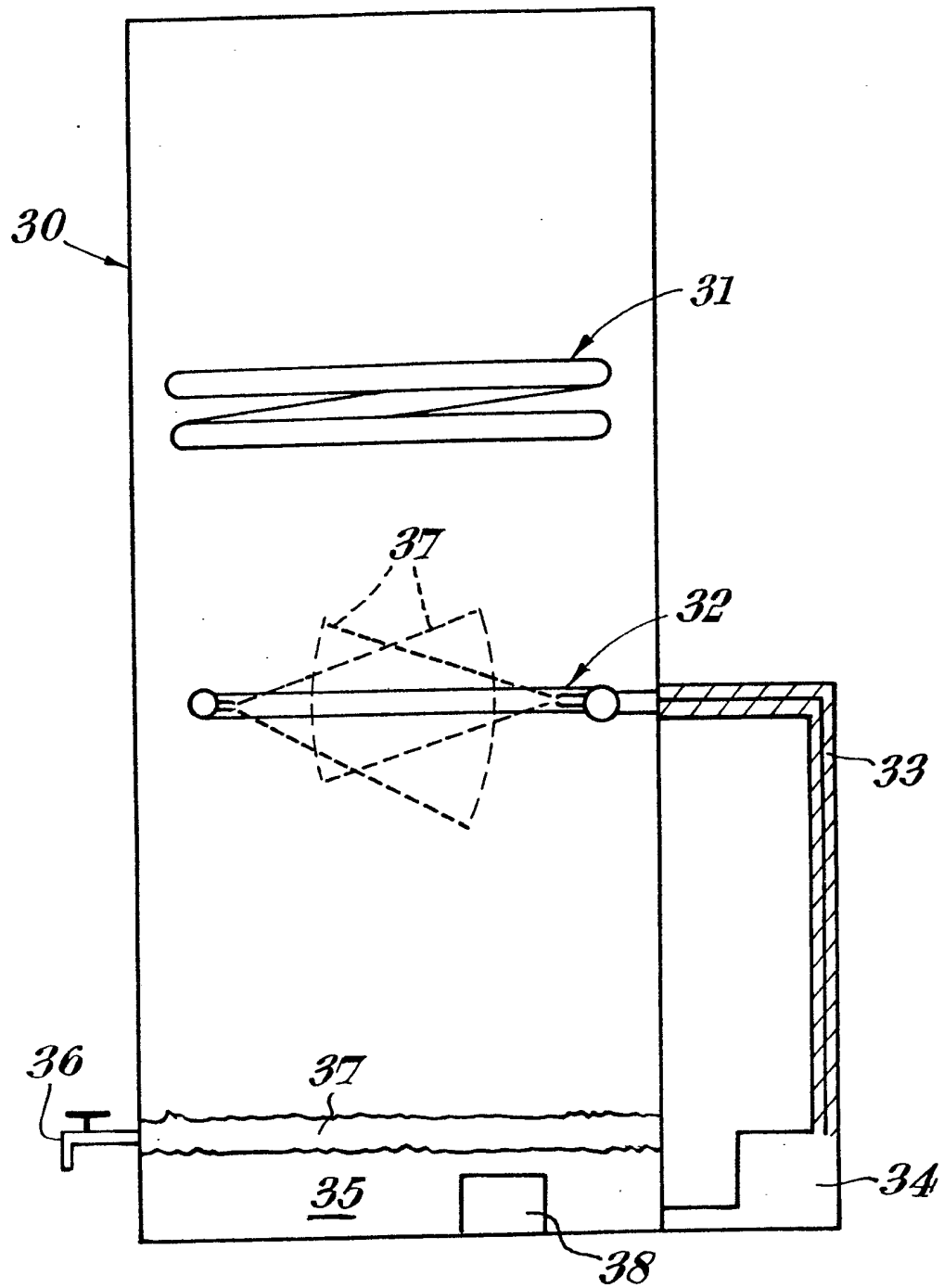


Fig. 1

*Fig. 2*

SPECIFICATION

Cleaning of chemically treated articles

This invention relates to the cleaning of chemically treated articles to avoid the production of unacceptable industrial waste.

In the production, for example, of plated articles, it is necessary to rinse the plating solution from the articles and possibly also from jigs which are used to support the articles during their handling and passage through the plating solutions. In the bright dipping of metal articles, the articles are immersed in a strong acid (usually aqua fortis) and residual acid coating the articles needs to be rinsed off. Similar comments apply to articles emerging from other chemical treatments, such for example as acid pickling and phosphating processes.

The rinse liquors which result from rinsing chemically treated articles may be highly toxic, and regulations at present in force in the United Kingdom are intended to prevent the discharge of the toxic liquors into public drainage or sewage systems. It is therefore necessary to treat the rinse liquor so as to render it non-toxic or to prevent a toxic rinse liquor from arising in the first place; this is not only necessary from the point of view of complying with Water Board or Public Health regulations but also desirable, in some cases, for economic reasons in order to recover or to try to recover the plating solution or the like which may contain valuable materials which can be re-used.

In accordance with a first aspect of the present invention, a method of cleaning a treated article as the final step of a chemical treatment operation comprises rinsing the treated article in a liquor which has a specific gravity higher than that of the chemical treatment liquid on the article and is immiscible therewith, whereby the chemical treatment liquid and the rinse liquor will automatically separate, and collecting the lighter fraction by any suitable means (such for example as a drainage tap or an over-flow weir) for re-use.

Whilst immersion in the rinse liquor is contemplated, it is also within the scope of the invention, if desired, to apply the rinse liquor for example by sprays so as to produce a mixture which, whilst turbulent, contains the higher specific gravity liquid and the lower specific gravity liquor, and to drain or spin the article and thereafter to collect the mixture for separation in a tank, and to take off the lighter fraction by any suitable means for re-use.

In accordance with one embodiment of said method according to the invention, the rinse liquor may also be immiscible in water and the chemical treatment liquid is in effect replaced by rinse liquor which, in a subsequent step, is replaced by water by further rinsing the article in a water bath; in the bath, the rinse liquor may be separated out for collection and re-use.

In accordance with a second aspect of the present invention, a method of cleaning a treated article as the final step of a chemical treatment

operation comprises the step of rinsing the chemical treatment liquid from the chemically treated article by using a low-volatility chlorinated hydrocarbon having a specific gravity substantially greater than 1 in order to replace said liquid by said hydrocarbon, and subsequently removing said hydrocarbon from the rinsed article by water, the chemical treatment liquid on the one hand and the hydrocarbon on the other hand being collected separately for re-use.

It is believed that perchloroethylene is a satisfactory example of such a hydrocarbon as is described in the preceding paragraph.

In accordance with a third aspect of the present invention, a method of cleaning a treated article as the final step of a chemical treatment operation comprises the step of rinsing the chemical treatment liquid from the chemically treated article by using a liquid chlorinated hydrocarbon having a specific gravity substantially greater than 1 and whose temperature has been raised to its boiling point; and allowing the hydrocarbon which has replaced the chemical treatment liquid on the surface(s) of said article to evaporate.

Preferably, the evaporation step is allowed to take place within the confines of a condenser region, whereby the evaporating hydrocarbon is returned to take part in rinsing of another article.

The rinsing may be effected by
 (a) immersion of said article in a bath of the liquid chlorinated hydrocarbon, or
 (b) immersion in a vapour phase region above a bath of the liquid chlorinated hydrocarbon, or
 (c) liquid chlorinated hydrocarbon being sprayed onto the surface(s) of said article.

The liquid chlorinated hydrocarbon may have a low volatility (one example of such a hydrocarbon is perchloroethylene) or it may have a high volatility (one example of such a hydrocarbon is marketed under the trade mark Arklone and is obtainable from Imperial Chemical Industries Limited. In using Arklone, it has been found to be desirable also to use an N-alkyl trimethylenediamine of which some are marketed under the trade mark Duomeen by Akzo U.K. Limited.

In one particularly efficacious embodiment of the method according to the third aspect of the present invention, the treated article is immersed in the liquid chlorinated hydrocarbon and is simultaneously subjected to the output of a device producing ultrasonic vibrations. It is believed, but not warranted, that the ultrasonic vibrations increase the throughput by helping to decrease the time taken for the hydrocarbon to replace the chemical treatment liquid, and that the cleaning is helped towards or reaches completeness.

Some embodiments of the present invention will now be described, by way of example only, with reference to the accompanying diagrammatic (schematic) drawings, in which:—
 Figure 1 represent an apparatus which includes an ultrasonic transducer submerged in a bath of a

liquid chlorinated hydrocarbon; and

Figure 2 represents an apparatus which is equipped with spraying means.

Referring firstly to Figure 1, there is illustrated in schematic form an apparatus which comprises a vessel 10 which is connected to a separator 11 by a pipe 12. A pump 13 has its suction side connected to the lower portion of the separator and has its output side connected by way of a pipe 14 to the lower portion of the vessel 10.

The reference numeral 15 indicates a bath containing a liquid chlorinated hydrocarbon in the bottom of which there is submerged an ultrasonic transducer 16. Above the level 17 of the bath 15 is a cooling device 18 which takes the form of a coil through which ordinary cold water is constantly circulated. The cooling device may take other forms and may use means other than cold water for cooling.

The vessel 10 is provided with means 19 for heating the liquid chlorinated hydrocarbon of the bath 15 to its boiling point. As a consequence of being so heated, the hydrocarbon material will form a vapour phase which extends between the level 17 and at least the lowermost part of the cooling device 18 which will constantly cause the vapour to condense on the device and to be returned to the bath 15 by dripping off the device.

In use of the apparatus to carry out an embodiment of the method according to the present invention, an article which has been chemically treated and which needs to be cleaned is either inserted into the space between the level 17 and the bottom of the device 18 or immersed in the bath 15, preferably the latter. The chemical treatment liquid on the surface(s) of said article is replaced by the chlorinated hydrocarbon and said liquid rises to the top of the bath 15 and is continuously ducted off by way of the pipe 12 to the separator 11 together with some of the bath material. In the separator, the materials separate into two different fractions of which 20 is the chemical treatment liquid and of which 21 is the hydrocarbon. The material 20 can be collected for re-use or for extraction of any valuable material(s), whereas the material 21 is pumped back into the bath 15.

When the article is lifted out of the liquid bath 15, it is allowed to dry in the vicinity of the device 18; the evaporating hydrocarbon material will be condensed by the device 18 and thus returned to the bath 15.

The bath 15 has so far only been described as containing a liquid chlorinated hydrocarbon but, in the preferred method, Arklone has been used together with Duomeen to form the liquid bath 15. These two substances do not form an emulsion and Duomeen does not react or combine with the water of the water-based chemical treatment liquid; in fact, the Duomeen increases the wetting ability of the Arklone which, of course, is required to replace the chemical treatment liquid on the surface(s) of the article. The use of the ultrasonic vibrator 16 (which may work at a typical 25 kilohertz in this application) is

thought to assist considerably in the step of displacing said chemical treatment liquid from said surface(s).

Referring now to Figure 2, a vessel 30 is equipped with a cooling device 31 (which can be the same as the cooling device 18 of the Figure 1 embodiment) and with a spray assembly 32 which is connected by a pipe 33 to a pump 34 whose suction side draws liquid chlorinated hydrocarbon and admixed surfactant from a reservoir 35 thereof. A tap 36 is provided for a purpose which will be explained.

The spray assembly 32 may consist of two diametrically opposed spray devices whose spray patterns are diagrammatically indicated by the dotted lines 37, or of any other appropriate or desirable arrangement such for example as an array of spray devices arranged around a circle and fed from a header pipe which is bent into/formed as a circle.

In operation, an article which has been chemically treated and which needs to be cleaned is lowered into spray area in which the liquid from the reservoir 35 is sprayed onto the surface(s) of said article in order to remove the chemical treatment liquid therefrom. The latter liquid, and the hydrocarbon, will fall back into the reservoir and the chemical treatment liquid will separate out into a layer 37 which can be drawn off, as necessary, by opening the tap 36.

The liquid in the reservoir 35 is or may be the same mixture as described with reference to Figure 1 but there may well be other liquid chlorinated hydrocarbons as suitable as Arklone and other surfactants as suitable as Duomeen. If perchloroethylene is used, Duomeen or some other surfactant will be added.

The cooling device 31 ensures that any vapour-phase chlorinated hydrocarbon will be condensed and returned to the reservoir.

The embodiment of Figure 2 may and preferably will be provided with a heater which is represented by the box 38. It is an object of heating the liquid in the reservoir 35 and in the bath 15 to ensure that the article which is cleaned also has its temperature raised significantly, if not to the temperature of said liquid. This raising of the temperature of the article has the effect of extremely rapid drying of the article in the cold condensing zone above the cooling device 18 or 31, respectively.

It should also be pointed out that the transducer 16 produces heat and this heat might be sufficient, in a small-scale apparatus, to enable the separate heating means 19 (Figure 1) to be dispensed with.

Claims

1. A method of cleaning a treated article as the final step of a chemical treatment operation, said method comprising the step of rinsing the treated article in a liquor which has a specific gravity higher than that of the chemical treatment liquid on the article and is immiscible therewith, whereby the chemical treatment liquid and the

rinse liquor will automatically separate, and collecting the lighter fraction by any suitable means (such for example as a drainage tap or an overflow weir) for re-use.

- 5 2. A method as claimed in Claim 1, wherein the treated article is immersed in a bath of said liquor.
3. A method as claimed in Claim 1, wherein said liquor is sprayed onto the treated article.
4. A method of cleaning a treated article as the
- 10 final step of a chemical treatment operation, said method comprising the step of rinsing the chemical treatment liquid from the chemically treated article by using a low-volatility chlorinated hydrocarbon having a specific gravity
- 15 substantially greater than 1 in order to replace said liquid by said hydrocarbon, and subsequently removing said hydrocarbon from the rinsed article by water, the chemical treatment liquid on the one hand and the hydrocarbon on the other hand
- 20 being collected separately for re-use.
5. A method as claimed in Claim 4, in which the low-volatility chlorinated hydrocarbon is perchloroethylene.
6. A method of cleaning a treated article as the
- 25 final step of a chemical treatment operation, said method comprising the step of rinsing the chemical treatment liquid from the chemically treated article by using a liquid chlorinated hydrocarbon having a specific gravity
- 30 substantially greater than 1 and whose temperature has been raised to its boiling point, and subsequently allowing the hydrocarbon which has replaced the chemical treatment liquid on the surface(s) of said article to evaporate.
- 35 7. A method as claimed in Claim 6, in which the evaporation step takes place within the confines of a condenser region, whereby the evaporating hydrocarbon is returned to take part in the rinsing of another article.
- 40 8. A method as claimed in Claim 6, in which said liquid chlorinated hydrocarbon is supplemented by a surfactant.
9. A method as claimed in Claim 8, wherein the treated article is immersed in the liquid
- 45 chlorinated hydrocarbon which is supplemented by said surfactant and wherein said article is simultaneously subjected to the output of a device producing ultrasonic vibrations whose frequency is such as will materially assist in the removal of said chemical treatment liquid from
- 50 the surface(s) of said article.
10. A method of cleaning a treated article as the final step of a chemical treatment operation, substantially as hereinbefore described with
- 55 reference to the accompanying diagrammatic drawing.
11. Any features of novelty, taken singly or in combination, of the embodiments of the invention hereinbefore described.