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LUBRICATING METAL SURFACES DURING COLD-WORKING

Albert G. Rocchini, Springdale, and Richard J. Neely, Oakmont, Pa., assignors to Gulf Research & Development Company, Pittsburgh, Pa., a corporation of Delaware

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This invention relates to lubricating metal surfaces during cold-working; and it comprises, in cold-working a metal subsequently to be annealed, a process improvement which resides in lubricating the surfaces of said metal by means of a lubricant comprising a petroleum lubricating oil containing a small amount of a chlorinated hydrocarbon; all as more fully hereinafter set forth and as claimed.

The cold-working of metals, such as the cold-rolling, drawing, or stamping of aluminum, stainless steel, Monel metal, and the like, is ordinarily followed by an annealing process. Annealing is often performed in a gas-fired furnace wherein the products of combustion come in contact with the metal. Owing perhaps to the restricted space adjacent the bulk of the metal surfaces, and furthermore to the fact that conditions in the furnace are not conducive to good combustion, it has been found that considerable staining of the metal has resulted. The stains which are formed may, in general, be classed according to three specific types. The first, a tempering stain, is believed to be an oxide formation which appears at the edge of a strip and is not thought to be dependent upon the type of lubricant employed. The second, having the appearance of a gray oxide, may appear in different positions on the strip and is believed to be caused by foreign matter such as dirt adhering to the surface and being carried on the strip into the annealing furnace. The third type of stain which may appear in streaks or spots is believed to be a carbon formation resulting when the working lubricant is subjected to the reducing atmosphere in the annealing furnace. It is the formation of the latter type of stain which the method of this invention inhibits or substantially retards.

In the past, the elimination of the stain resulting from the lubricant has been accomplished by one of several alternatives. In one embodiment, the oil stain has been eliminated by removing the lubricating oil film from the cold-worked metal with a solvent prior to the annealing step. Other embodiments have included chemically or mechanically removing the stain after the annealing operation. These embodiments, however, introduce expensive processing steps.

The type of lubricant employed in cold-working processes has also been the subject of many prior investigations. Among the lubricants which have been used are included animal oils, vegetable oils, mineral oils, and mixtures of these and water-oil emulsions. Animal and vegetable oils are

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effective lubricants, but they have certain disadvantages in that they are rather expensive, are not good coolants, and are easily oxidized with the resultant development of rancidity. Furthermore, animal and vegetable oils, having high carbon residue values, have been unsatisfactory in that unless they are removed from the worked metal prior to its being annealed, they will leave stains in the form of carbon deposits on the metal when it is subsequently annealed. While straight mineral oils are satisfactory with respect to their cost, cooling properties, and stability, they, as do the animal and vegetable oils, also have a disadvantage in that unless they are removed from the worked metal prior to its being annealed, they will leave a stain on the surface of the annealed metal. Water-oil emulsions are advantageous in that they may easily be removed from metal surfaces by washing with water prior to annealing, but this step in itself complicates the working process. Water-oil emulsions have a further disadvantage in that with repeated use as cold-working lubricants, the water tends to evaporate from the water-oil emulsions thereby changing the ratio of water to oil. Since the ratio of water to oil should be kept as uniform as possible to obtain optimum results, frequent analysis of the lubricant is required thereby adding complexity to the process.

It is the primary object achieved by this invention to provide a method of lubricating metal surfaces during cold working by means of a lubricant which if allowed to remain on the metal during a subsequent annealing operation will not stain the metal or deposit carbon residues thereon.

This and other objects achieved by this invention will become apparent in the following detailed description thereof.

According to our invention, the surfaces of a metal being worked are lubricated by establishing and maintaining thereon a film of lubricant comprising a lubricating oil which would normally tend to stain said metal surfaces during annealing thereof and a small amount, sufficient to inhibit or greatly retard such staining, of a chlorinated hydrocarbon boiling above about 100° C.

Among the chlorinated hydrocarbons which we have found effective in rendering petroleum lubricating oils non-staining at elevated temperatures may be included chlorinated paraffinic, chlorinated naphthenic, and chlorinated aromatic hydrocarbons. Low-boiling chlorinated hydrocarbons are generally not suitable for use in accordance with our invention, because low-boiling

materials tend to vaporize out of the cold-working lubricant before the annealing step is reached. Therefore, we prefer the relatively higher-boiling chlorinated hydrocarbons, such as chlorinated hydrocarbons boiling above about 100° C. Among the more common chlorinated hydrocarbons which we have found satisfactory, may be mentioned the chlorinated derivatives of paraffin wax and kerosene, the relatively higher-boiling naphthenic and paraffinic petroleum fractions, and mixtures of these. The chlorinated hydrocarbons may be prepared by treating the hydrocarbons with chlorine in glass-lined chlorinators under conventional chlorinating conditions. The chlorine-containing hydrocarbons may, in general, contain between about 20 and about 50 per cent by weight of chlorine and, in some instances, even as much as 70 per cent by weight of chlorine or higher. However, we preferably use a chlorinated hydrocarbon containing between about 40 and about 45 per cent by weight of chlorine. Ordinarily, if the chlorine content of the hydrocarbon is appreciably less than about 20 per cent by weight, then too much of the chlorinated hydrocarbon must be added to the oil to be commercially practicable. In accordance with our invention, the chlorinated hydrocarbon is ordinarily employed in an amount sufficient to produce a chlorine content in the final cold-working lubricant between about 0.01 and 1.0 per cent by weight. Thus, when a chlorinated hydrocarbon containing 40 per cent by weight of chlorine is used. we have found that the chlorinated hydrocarbon is advantageously incorporated in the oil in an amount between about 0.025 and 2.5 per cent by weight. The exact amount of chlorinated hydrocarbon employed will depend upon the particular type of hydrocarbon which has been chlorinated, as well as upon the extent to which the hydrocarbon has been chlorinated. For instance, we have observed that chlorinated paraffinic hydrocarbons are generally more effective than chlorinated aromatic compounds. Accordingly, it can be stated that for chlorinated hydrocarbons containing the same amount of chlorine, a chlorinated paraffin hydrocarbon may be used in a smaller amount than a chlorinated aromatic hydrocarbon. In any case, the amount of chlorinated hydrocarbon used is sufficient to substantially retard the formation of an oil stain on a metal when the metal containing a film of cold-working lubricant is annealed.

In the practice of our invention any suitable lubricating oil base, whether it is derived from a paraffinic, naphthenic, or mixed base crude, may be employed. Although it is seldom necessary in compositions of the type disclosed herein, the lubricating oil base may contain one or more of the so-called "additive" agents including oiliness and extreme pressure agents, viscosity index improvers, pour point depressants, foam inhibitors, and corrosion and oxidation inhibitors. The particular lubricant chosen depends on the type of cold-working operation for which it is intended. For example, oils used in cold-rolling are generally highly refined and are relatively volatile having viscosities between about 50 and 200 SUS at 100° F., whereas oils used in drawing operations may have viscosities as high as 5000 SUS at 100° F. It is not intended to limit this invention with respect to the particular lubricating oil base.

The advantages to be obtained in accordance with our invention are illustrated in the following comparative laboratory tests made on a highly refined naphthenic base oil having a Saybolt Universal Viscosity of 53 at 100° F. and the same oil containing various chlorinated hydrocarbons. To simulate actual operating conditions of the annealing of cold-rolled aluminum, 1 ml. of the oil to be tested was placed between two aluminum plates (99.2% aluminum). The aluminum plates were then placed in a muffle furnace for 30 minutes at a temperature of 650° F., this being the temperature of the metal as determined by a thermocouple. The plates were then removed and inspected. The appearance of the aluminum after annealing, as tabulated hereinbelow, was determined by visual inspection and comparison with a blank set of plates.

Chlorinated Hydrocarbon Incorporated in a Highly Refined Naphthenic Base Oil (53 SUV at 100° F.)	Per Cent by Weight	Appearance of Aluminum after Annealing
None		Severe Stain.
Chlorinated biphenyl (19% Cl)	1.0	No Stain.
Chlorinated biphenyl (41% Cl)	0.25	Slight Stain.
Do	0.5	No Stain.
Chlorinated paraffin wax (42% Cl)	0.05	Slight Stain.
Do	0.25	No Stain.
Do	0.5	Do.
Do	1.0	Slight Stain.
Do	2.0	Do.
Chlorinated naphthalene (58% Cl)	0.05	No Stain.
Chlorinated biphenyl (62% Cl)	0.05	Do.
Do	0.25	Do.
Chlorinated paraffin wax (70% Cl)	0.017	Do.
Do	0.23	Slight Stain.

While the above table reports the results obtained on aluminum plates only, the method of our invention is advantageous when applied to any metal being cold worked and subsequently to be annealed. For instance, the method of our invention is applicable to the cold working of non-ferrous metals other than aluminum, such, for example, as magnesium or Monel metal, particularly when such metals are to be annealed after cold working, and where it is desirable that the surface of such metals be clean and bright after annealing. The method of our invention is also applicable to the cold-rolling of stainless steel. For example, when stainless steel of the 18 per cent chromium and 8 per cent nickel type was tested as above-described with the base oil plus 0.25 per cent by weight of chlorinated paraffin wax (42% chlorine), only a slight stain appeared as compared to another sample of the same steel which was severely stained when coated only with the base oil. The method of our invention obviates the expensive step of removing the oil film from the metal prior to its being annealed and, at the same time, overcomes the staining which normally would occur in the annealing operation when employing a straight mineral lubricating oil as a lubricant for the cold working of metals.

While our invention has been described herein with particular reference to certain specific embodiments thereof by way of illustration, it is to be understood that the invention is not limited to such embodiments except as hereinafter defined in the appended claims.

We claim:

1. A metal finishing process which comprises cold working a metal while maintaining on the surfaces of said metal a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said metal surfaces during the annealing thereof and a chlorinated hydrocarbon boiling above about 100° C., said chlorinated hydrocarbon being present in an amount sufficient to produce a chlorine content

in the film of lubricant between about 0.01 and 1.0 per cent by weight, and, without removing the film of lubricant from the surfaces of the cold-worked metal, annealing said cold-worked metal.

2. A metal finishing process which comprises cold working a metal while maintaining on the surfaces of said metal a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said metal surfaces during the annealing thereof and a chlorinated hydrocarbon boiling above about 100° C. and containing between about 20 and about 50 per cent by weight of chlorine, said chlorinated hydrocarbon being present in an amount sufficient to produce a chlorine content in the film of lubricant between about 0.01 and 1.0 per cent by weight, and, without removing the film of lubricant from the surfaces of the cold-worked metal, annealing said cold-worked metal.

3. A metal finishing process which comprises cold working a metal while maintaining on the surfaces of said metal a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said metal surfaces during the annealing thereof and a chlorinated paraffin wax in an amount sufficient to produce a chlorine content in the film of lubricant between about 0.01 and 1.0 per cent by weight, and, without removing the film of lubricant from the surfaces of the cold-worked metal, annealing said cold-worked metal.

4. A metal finishing process which comprises cold working a metal while maintaining on the surfaces of said metal a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said metal surfaces during the annealing thereof and between about 0.025 and 2.5 per cent by weight of a chlorinated paraffinic-naphthenic liquid hydrocarbon, said liquid hydrocarbon containing about 40 per cent by weight of chlorine, and, without removing the film of lubricant from the surfaces of the cold-worked metal, annealing said cold-worked metal.

5. An aluminum finishing process which comprises cold rolling aluminum while maintaining on the surfaces of said aluminum a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said aluminum surfaces during the annealing thereof and a chlorinated paraffin wax in an amount sufficient to produce a chlorine content in the film of lubricant between about 0.01 and 1.0 per cent by weight, and, without removing the film of lubricant from the surfaces of the cold-rolled aluminum, annealing said cold-rolled aluminum.

6. An aluminum finishing process which comprises cold rolling aluminum while maintaining on the surfaces of said aluminum a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said aluminum surfaces during the annealing thereof and a chlorinated naphthenic hydrocarbon in an amount sufficient to produce a chlorine content in the film of lubricant between about 0.01 and 1.0 per cent by weight, and, without removing the film of lubricant from the surfaces of the cold-rolled aluminum, annealing said cold-rolled aluminum.

7. An aluminum finishing process which comprises cold rolling aluminum while maintaining on the surfaces of said aluminum a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said aluminum surfaces during the annealing thereof and between about 0.025 and 2.5 per cent by weight of a chlorinated paraffinic-naphthenic liquid hydrocarbon, said liquid hydrocarbon containing about 40 per cent by weight of chlorine, and, without removing the film of lubricant from the surfaces of the cold-rolled aluminum, annealing said cold-rolled aluminum.

8. A stainless steel finishing process which comprises cold rolling stainless steel while maintaining on the surfaces of said stainless steel a film of lubricant consisting essentially of a petroleum lubricating oil which would normally tend to stain said stainless steel surfaces during the annealing thereof and a chlorinated paraffin wax in an amount sufficient to produce a chlorine content in the film of lubricant between about 0.01 and 1.0 per cent by weight, and, without removing the film of lubricant from the surfaces of the cold-rolled stainless steel, annealing said cold-rolled stainless steel.

ALBERT G. ROCCHINI.
RICHARD J. NEELY.

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