

Jan. 27, 1959

J. A. M. LEDUC
METAL DRAWING LUBRICANT

2,870,903

Filed April 8, 1955

4 Sheets-Sheet 1

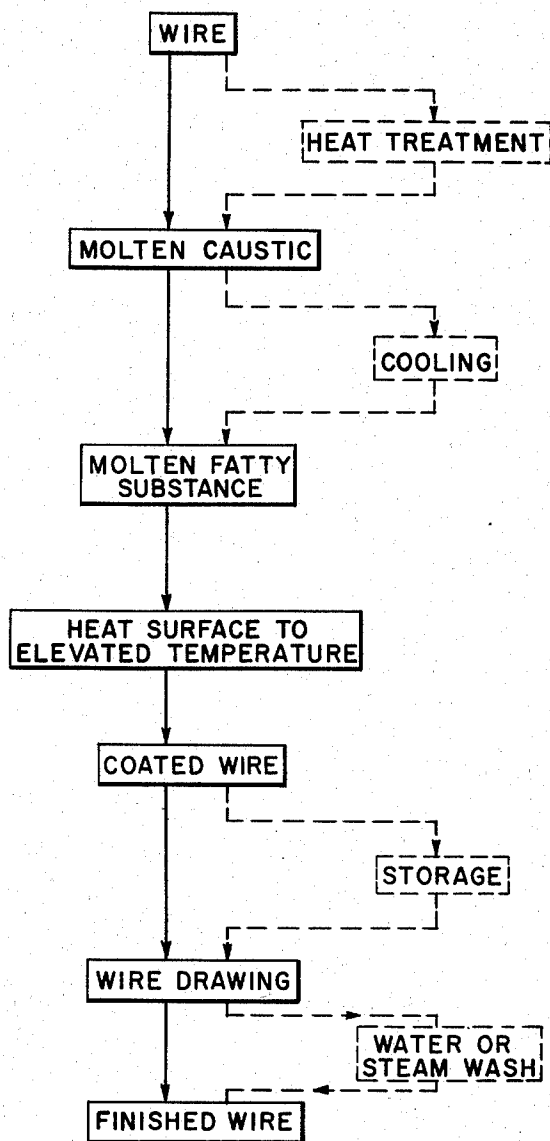


FIG. 1

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4 Sheets-Sheet 2

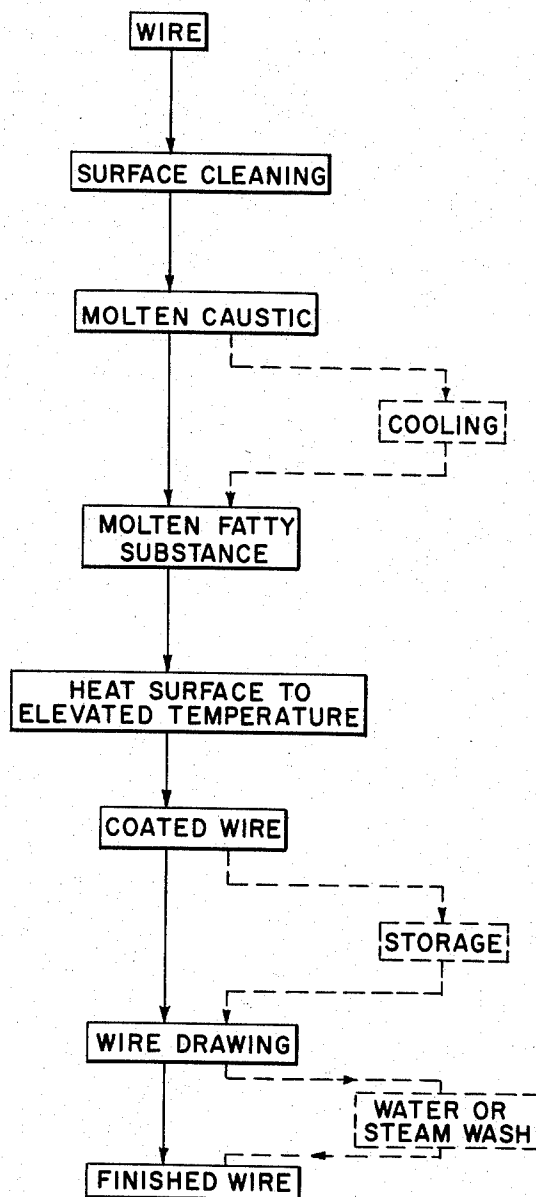


FIG. 2

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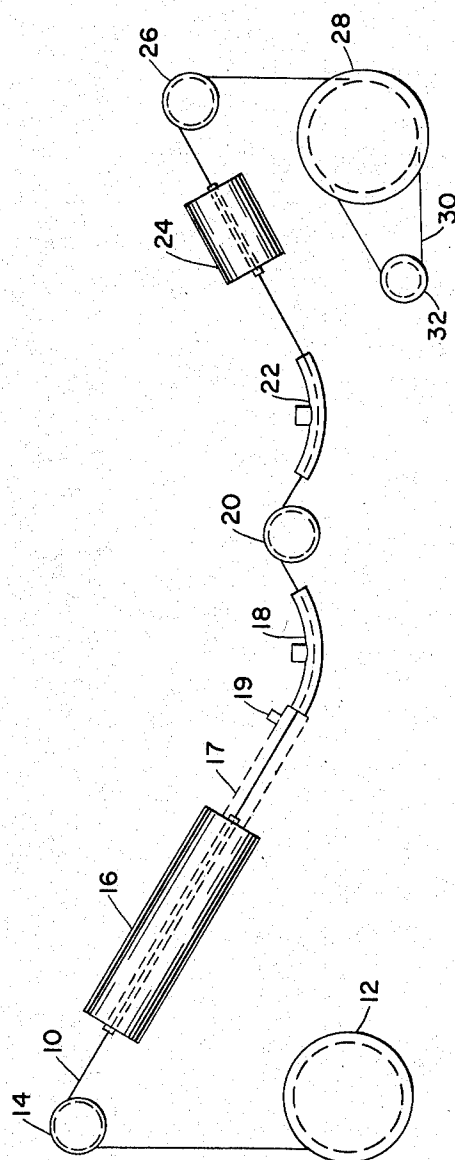
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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

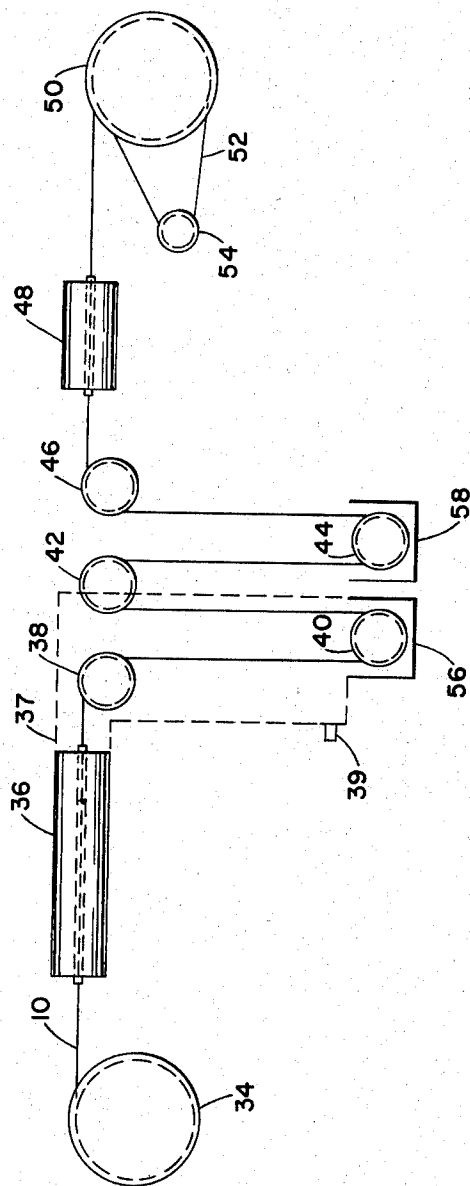


FIG. 4

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2,870,903

METAL DRAWING LUBRICANT

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Application April 8, 1955, Serial No. 500,058

2 Claims. (Cl. 205—21)

This invention relates to metal processing, and more particularly relates to improvement in coating and lubrication of metals, such as wire or other metal to be drawn.

Up to the present time there has been proposed and used a variety of metal surface treating processes preparatory to wire drawings and other metal-forming operations. While these prior treatments have differed greatly in their details, they may generally be classified into several groups.

One type of prior metal treatment contemplates a descaling treatment, followed by acid pickling and lime treatment, with or without a subsequent glyceride coating. Processes of this type, while used commercially, involve a relatively large number of operations and have certain inherent disadvantages, including the additional process control required and costs involved. Additionally, in many processes of this type, organic solvents are employed as carriers for any lubricant coating applied. These solvents generally must be removed and often leave an objectionable greasy residue on the metal.

Another prior process involves passing wire, or other metal to be treated, through a molten salt, for example, molten caustic, followed by either aqueous washing, without further treatment, or by aqueous washing together with additional metal treatments. Such processes, in some instances, are satisfactory. However, any coating or film thereby formed on the metal is but a surface layer which can be relatively easily removed. Moreover, the intermediate aqueous washings remove much of any such surface coating.

A third type of metal treatment contemplates passing wire or other metal through a molten bath comprising the reaction product of caustic soda and a fatty acid. This procedure thus involves passing the metal through a molten soap, generally in the presence of caustic. Again, while a soap film is applied to the surface of the metal by this technique, the coating comprises a preformed soap which may be relatively easily removed from the metal surface.

Since the removal of even a small amount of surface coating in wire drawing may seriously impair the quality of the drawn wire, or injure the drawing dies, it will be appreciated that while the prior art metal treating processes do provide various types of lubricant films, the heretofore proposed processes have not been a completely satisfactory solution to the problem of preparing metal for drawing operations.

Accordingly, the present invention has for its principal object the provision of a new and improved metal treating process which avoids the difficulties heretofore encountered in conditioning metal prior to deep drawing operations.

A further object of the invention is the provision of a new and improved adherent, protective lubricant for metals.

A still further object of the invention is to provide a

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new and improved metal treating process of conditioning a metal surface for subsequent treatment.

These and other objects and advantages of the invention will appear more fully from the following description.

Generally, the present invention is based upon the discovery that an improved, uniform, adherent and durable surface diffusion layer can be provided on metal by contacting such metal successively with a first bath comprising at least one molten alkali metal hydroxide and a second bath comprising at least one molten fatty substance, such as a molten fatty acid, capable of chemical reaction with said hydroxide to form a strongly adherent, protective, lubricant surface diffusion zone at and beneath the metal surface and thereafter subjecting this surface diffusion zone to an elevated temperature.

In general, the elevated temperature to which the surface diffusion zone is heated, and the length of time it is exposed to such a temperature, may be varied, depending on the particular application. However, it is, of course, desirable that the metal itself not be appreciably heated, at least not heated to the extent that the metal surface diffusion layer bond is impaired. On the contrary, it is preferable only briefly to expose the surface of the diffusion layer to a relatively high temperature atmosphere, e. g., 1000°–1500° F., as by passing the metal through a furnace maintained at such a temperature.

In practice, excellent results have been obtained by passing metal, treated with molten alkali metal hydroxide and a molten fatty substance, through a furnace maintained at a temperature within the range from the melting point of the molten fatty substance to a higher temperature dictated by the application intended and the speed at which the treated metal will be passed through the furnace. In certain applications, temperatures as high as 2000° F. may be used. At present, in treating wire it is preferred to expose the surface diffusion zone to an atmosphere maintained at a temperature within the range from about 1000°–1500° F. by passing the treated wire through such an atmosphere at a rate of from 10 to 20 feet per minute. Those skilled in the art will recognize that by increasing the speed at which treated wire is passed through a high temperature atmosphere a corresponding increase in the temperature employed is required in order to accomplish the same amount of heating.

By the practice of this invention the molten alkali metal hydroxide provides a penetrating and cleansing action on the metal being treated. Further, this beneficial action of the alkali metal hydroxide establishes the alkali metal hydroxide in highly reactive form, both at the metal surface and deep within the pores of the metal. Hence, when a thus-treated metal is contacted with a molten fatty substance, such as a fatty acid, a chemical reaction occurs not only at the surface of the metal, but after penetrating or diffusing into the metal within the metal pores as well to establish what is herein referred to as a "surface diffusion zone." The subsequent elevated temperature treatment or baking further enhances the desirable features of the surface by removing unreacted fatty substance and providing a smoother, more uniform surface. Accordingly, the resultant reaction product surface diffusion zone is extremely difficult to remove by abrasion, as well as by such handling metal receives in industry prior to further treatment.

Another inherent advantage is realized since the heat treated reaction product comprising the improved surface diffusion zone essentially is a soap or other lubricant soap-like material; not only are excellent lubricant characteristics provided, but removal of this surface dif-

fusion zone when desired may be accomplished readily by washing with water or steam without an elaborate or costly cleaning procedure.

The preferred practice of the invention at present contemplates first preheating metal to an elevated temperature, above the temperature of the molten alkali metal hydroxide employed, quenching the thus-heated metal in the first molten bath comprising molten alkali metal hydroxide, and passing the metal into a second molten bath, containing a fatty acid or other substance capable of reacting with the molten hydroxide, as indicated above. The thus-treated metal is then subjected to an elevated temperature for a short time, the temperature being high enough substantially completely to remove unreacted fatty acid or other unreacted fatty substance and the exposure time being sufficiently brief so that the surface diffusion layer itself is not injured, nor, in most instances, is the metal appreciably heated.

Those skilled in the art will appreciate that the foregoing sequence is particularly advantageous where it is desired first to anneal or otherwise heat treat wire or other metal to be processed, since such metal can advantageously be transported directly from the heating furnace, preferably through an inert or reducing atmosphere, such as hydrogen, cracked petroleum gas, argon, nitrogen, carbon dioxide, mixtures thereof, or the like, into the molten alkali metal hydroxide of this invention without intermediate treatment.

As used throughout the specification and claims, the expression "alkali metal hydroxide" is intended to include hydroxides of the various alkali metals, e. g., sodium, potassium, rubidium, cesium, and lithium. However, sodium and potassium hydroxides are, of course, the commonly used alkali metal hydroxides. Because of its availability and low cost, sodium hydroxide is the preferred material at present, and particular reference will be made hereinafter to sodium hydroxide, although the practice of this invention is not limited thereto.

The second molten bath comprising the material capable of reacting with the alkali metal hydroxide to form an adherent, protective, lubricant surface diffusion zone may comprise a variety of materials capable of forming an adherent reaction product upon chemical combination with an alkali metal hydroxide. Such materials include oils, greases, fats, fatty oils, fatty acids, and fatty acid derivatives, such as fatty acid esters, amides, and the like, and are generally termed "fatty substances" herein. At present, it is preferred to employ one or a mixture of fatty acids of commercial purity. Superior results are obtained using a fatty acid or fatty acid mixture which solidifies at a temperature well above room temperature, i. e., 70° F. Typical fatty acids which may be employed, either alone or in admixture, include such saturated fatty acids as

caproic
caprylic
capric
lauric
myristic
palmitic
stearic
arachidic
behenic, and
lignoceric acids

as well as unsaturated fatty acids, such as

myristoleic
palmitoleic
oleic
linoleic
linolenic
elaeostearic
licanic
ricinoleic, and
erucic acids

In some instances, natural oils and fats containing substantial proportions of one or more of such fatty acids also may be employed. Illustrative of such materials are tallow or lard, fish oils, such as whale, menhaden, sardine, and herring, plant oils, such as coconut, palm kernel, babassu, murumuru, palm, rape seed, mustard seed, olive, peanut, sesame, corn, cottonseed, soybean, sunflower, walnut, linseed, perilla, castor, tung, and oiticica oils, as well as certain halogenated derivatives thereof. However, as pointed out hereinbefore, it is preferable to utilize a fatty substance which, upon reaction with the alkali metal hydroxide, forms a continuous solid reaction product layer and which has a relatively high flash point in order to minimize danger of fire caused by contact with hot metal. Any danger from such flash fires can also be prevented, of course, by blanketing the molten baths with an inert atmosphere.

In some instances it is desirable to incorporate one or more additives in the molten baths of this invention. Suitable additives for the molten alkali metal hydroxide bath include substances to lower the melting point of the caustic and/or to improve the cleansing action of the caustic. Additives for the molten fatty substance may include sulfur-containing substances, such as molybdenum disulfide, sodium sulfide, sodium sulfite, as well as other lubricant-type materials, e. g., mica, graphite, and the like.

Referring now to the drawings,

Fig. 1 is a schematic flow diagram illustrating one embodiment of the method of this invention;

Fig. 2 is a schematic flow diagram illustrating another embodiment of the method of this invention;

Fig. 3 is a schematic representation of one form of apparatus which may be used in the treatment of wire in accordance with this invention; and

Fig. 4 illustrates schematically another type of apparatus for the treatment of wire in accordance with this invention.

Referring to Fig. 1, wire first is passed into molten caustic and then into a molten fatty acid, thereby to form, in situ, a surface diffusion zone of a lubricant soap coating. As indicated in Fig. 1, the wire may be, and at present preferably is, subjected to a heat treatment, such as annealing at 1600°-1850° F., the temperature depending on the type of wire being processed prior to immersion in the molten caustic. Optimum results are obtained when the wire is heated to a temperature in excess of the temperature of the molten caustic thereby to obtain a quenching effect when the wire is contacted with the molten caustic. In this heat treatment there preferably is provided an inert atmosphere, e. g., nitrogen, carbon dioxide, or the like, surrounding the wire. In practice, it is frequently advantageous to extend the furnace exit tube beneath the surface of the molten caustic to insure maintenance of the desired inert atmosphere.

The wire is then passed from the molten caustic directly into the molten fatty acid without intermediate treatment, although in some instances, it is desirable to accomplish a predetermined amount of cooling intermediate the first and second molten baths, as by passage of the wire over one or more pulleys or spools intermediate the molten baths. Such cooling is only required when it is necessary to minimize danger of igniting the second molten bath, e. g., fatty acid, upon contact with the heated metal.

After removal from the second bath, the wire is subjected to an elevated temperature in a baking or other heat treatment operation. Such a heat treatment is not intended appreciably to heat the wire itself but, on the contrary, briefly to expose the surface of the lubricant layer to an elevated temperature. The singular improvement obtained by such heat treatment, or baking, is that any unreacted excess fatty substance mechanically car-

ried out of the molten bath is thereby removed and a smoother, more uniform continuous layer having a harder surface is obtained.

The resultant coated wire may then either be stored or shipped without further treatment, or passed directly through wire-drawing dies. The drawn wire still retains an appreciable thickness of a continuous uniform, protective and lubricating surface layer. In some instances, it is desirable to remove this layer by treatment with water, or, preferably, by steam treatment. In other cases, since this layer is extremely adherent and offers continued protection against rust, corrosion, and abrasion, it is advantageous to ship or store the wire without removal of this layer.

Fig. 2 illustrates a modification of the process of this invention which does not involve heat treatment of the wire prior to contact with molten caustic. In the process shown in Fig. 2, wire is subjected to surface cleaning prior to caustic treatment. Typical of the surface cleaning treatments contemplated are such conventional metal cleaning procedures as sand blasting, acid pickling, acid etching, and/or other abrasive or chemical treatment, including electrolytic metal surface cleaning operations. It should be emphasized that in many applications no pretreatment of the metal is necessary at all, the molten caustic according a thorough rust removing and surface cleansing action. The wire is then subjected to the same sequence of operations illustrated in Fig. 1, which operations, of course, may or may not include cooling intermediate the molten baths.

Fig. 3 illustrates, in schematic form, apparatus particularly adapted in the treating of hard drawn wire in accordance with this invention. The apparatus shown in Fig. 3 for treating a wire 10 comprises a storage reel 12, a feed pulley 14, a first tubular heat treating furnace 16, a molten caustic container 18, a guide pulley 20, a molten fatty acid container 22, a second tubular heat treatment furnace 24, a discharge pulley 26, and a take-up pulley 28 driven through belt 30 by a motor 32. Those skilled in the art will realize that a variety of types of supporting structures (not shown) may be employed in utilizing the apparatus shown in Fig. 3. To provide an inert or reducing atmosphere when desired, there may be provided tubular extension 17 having a gas inlet 19 for countercurrently introducing the desired atmosphere-providing gas, e. g., nitrogen. Alternatively, the outlet of the furnace 16 and the molten caustic container may be juxtaposed to eliminate exposure of the wire prior to contact with the caustic.

The molten caustic container 18 and the molten fatty acid container 22 may be fabricated from nickel, steel, Monel, or other chemical- and temperature-resistant metal or alloy. Each of the containers 18 and 22 preferably comprises a curved tubular member, e. g., 12 inch radius, having an inlet intermediate its ends, and a radius of curvature dictated by the minimum bending radius the wire to be processed can withstand. Hence, it will be appreciated that the containers 18 and 22, having a relatively large radius of curvature, permit the processing of hard drawn wire which is capable of only a slight degree of bending without rupture. Moreover, containers of this type have the additional advantage of permitting the use of relatively small quantities of molten caustic and molten fatty acid.

In order to provide the desired elevated temperature within the containers 18 and 22, each container is provided with suitable heating means, such as a longitudinally extending heating coil comprising an electrical resistance heating element (not shown). In order to minimize heat loss the containers 18 and 22 preferably are suitably covered with asbestos or other insulation.

In operation, using the apparatus of Fig. 3, wire 10 is passed continuously from the storage reel 12 over feed pulley 14 through the heat treatment furnace 16 where- in any desired heat treatment in advance of caustic im-

mersion may be provided, through molten caustic in the container 18, over guide pulley 20, through molten fatty acid in container 22, through the heat treatment furnace 24, over the discharge pulley 26, and onto take-up pulley 28.

Referring to Fig. 4, which illustrates another form of apparatus which may be used in treating wire 10' in the practice of this invention, there is provided a storage spool 34, a first heat treatment furnace 36, guide spools 38, 40, 42, 44, and 46, a molten caustic container 56 provided with heating means (not shown), and a molten fatty acid container 58, also provided with heating means (not shown), a second heat treatment furnace 48, and a take-up spool 50 driven through belt 52 by a motor 54. There is indicated schematically in broken lines at 37 one embodiment of apparatus permitting the use of a special atmosphere, e. g., inert or reducing, in the furnace 36 without exposure of the wire 10' to the outside atmosphere prior to contact with the molten caustic. There is also provided an inlet 39 for introduction of the desired atmosphere-providing gas, e. g., nitrogen. The operation of the apparatus illustrated in Fig. 4 is similar to that previously described. The sequence of operations is as follows: Wire 10' is taken continuously from storage reel 34, passed successively through the first heat treatment furnace 36, through molten caustic in container 56, and molten fatty acid in container 58, through the second heat treatment furnace 48 and onto the take-up spool 50.

The various heat treatment furnaces indicated in the drawings may comprise different types of apparatus, including flame heated devices, depending upon the particular application. However, it has been found practicable in most instances to employ a tubular heating chamber having a relatively small diameter, e. g., 1/2" to 1 1/2" or less, the size, of course, being dictated by the size of wire or other metal processed, and providing adequate heating by a spirally disposed electrical resistance heating element about the tubular heating chamber. Those skilled in the art will realize, of course, that a suitable electrical resistance heating element may comprise Nichrome wire, and the tubular heating chamber may be formed from a heat resistant metal, such as nickel, steel, or other suitable metal or alloy, or, if desired, from a heat-resistant metallic or non-metallic refractory substance, such as glass or other refractory. It is desirable to provide heat-resistant insulation about the heating chamber and heating element, a typically practicable insulation being fibrous asbestos or other mineral substance, with or without a heat-resistant binder.

In order that those skilled in the art may more completely understand the present invention and the preferred methods by which the same may be carried into effect, the following specific examples are offered:

Example I

A non-annealed steel wire 0.081" in diameter, moving at a speed of 10 feet per minute, is first passed through a 3-foot long, 1/4" diameter, electrically heated tubular furnace at a temperature of 1835° F. The wire emerging from the furnace is at red heat and has an approximate temperature of 1475° F. This preheated wire passes continuously into molten sodium hydroxide, which has a temperature of 680° F. The wire then is immersed in molten stearic acid maintained at a temperature of 300° F. The continuously moving wire is then passed through an 18" long, 1 1/2" diameter tubular furnace maintained at a temperature of 1265° F.

The thus-treated wire is then passed through wire-drawing dies wherein, in one pass, it is subjected to a substantial reduction, i. e., 30%, in diameter. The wire draws readily without injury to the die or accumulation of excess coating thereon. The drawn wire retains an adherent protective surface diffusion zone which may be

either removed by water or steam washing, or may be allowed to remain on the wire for protective purposes.

Example II

The procedure of Example I is repeated using palmitic acid instead of stearic acid. Substantially the same results are obtained.

Example III

Employing apparatus of the type illustrated in Fig. 3, using a tubular furnace having a temperature of 1475° F. and provided with a nitrogen atmosphere, iron wire is heated to red heat and passed successively through molten sodium hydroxide at 680° F. and stearic acid at 212° F. There is obtained a durable, protective and lubricant surface on the wire.

Example IV

The procedure of Example III is repeated and the treated wire is passed at a speed of 10 feet per minute through a second tubular furnace maintained at 1475° F. to obtain a harder, more uniform surface and to facilitate removal of unreacted stearic acid.

Example V

The procedure of Example IV is repeated, using potassium hydroxide instead of sodium hydroxide. Substantially identical results are obtained.

Example VI

To illustrate the use of molten alkali metal hydroxide in combination with other fatty substances, a series of experiments are conducted in the following manner. Iron wire is pickled in 50% hydrochloric acid for 5 minutes, rinsed in water, and then heated to 1350° F. in a quartz tube by gas burners. A nitrogen atmosphere is provided in the furnace.

The thus-treated wire is then dipped for 5 seconds in molten sodium hydroxide maintained at a temperature of 680° F. and thereafter immediately dipped into a second molten bath for 5 seconds, the second bath being maintained at a temperature of 300° F. The thus-treated wires are then passed rapidly through the heated quartz tube to obtain an improved coating surface. The following table indicates the compositions of the second molten bath and the type of reaction observed:

Fatty Substance	Reaction Observed
Tung Oil.....	Mild Reaction.
Soybean Oil.....	Do.
Menhaden Oil.....	Do.
Tall Oil.....	Vigorous Reaction.
Sunflower Oil.....	Mild Reaction.
Olive Oil.....	Do.
Cottonseed Oil.....	Do.
Linseed Oil.....	Do.
Castor Oil.....	Do.
Caproic Acid.....	Vigorous Reaction.
Oleic Acid.....	Do.

Although, as indicated in the above table, a reaction is noted in each instance, the adherency and surface characteristics of the resultant coating vary, depending on the composition of the second molten bath.

Example VII

The procedure according to Example VI is repeated using somewhat different temperature conditions. In this set of experiments the tubular furnace temperature is maintained at 1832° F., the molten sodium hydroxide temperature is 932° F., and the fatty substance temperature is 302° F., the coated wire samples being passed through the tubular furnace after immersion in the molten fatty substance in addition to an initial pass through for

preheating. The reactions observed with specific molten fatty substances are shown in the following table:

Fatty Substance	Reaction Observed
Tung Oil.....	Mild Reaction—Short Duration.
Soybean Oil.....	Mild Reaction.
Menhaden Oil.....	Do.
Tall Oil.....	Vigorous Reaction.
Sunflower Oil.....	Mild Reaction.
Olive Oil.....	Do.
Cottonseed Oil.....	Do.
Linseed Oil.....	Do.
Castor Oil.....	Do.
Caproic Acid.....	Vigorous Reaction.
Oleic Acid.....	Do.

Example VIII

A further series of experiments are conducted according to the procedure of Example VI, except that after the wire is washed with water, following acid pickling, it is placed in an oven maintained at 212° F. for 15 minutes. The tubular furnace temperature is maintained at 1562° F., the molten sodium hydroxide temperature is 932° F., and the molten fatty substance temperature is 302° F. The results of such runs using the fatty substances, wherein the coated surfaces are subjected to an elevated temperature following immersion in the second molten bath, are set forth in the table below:

Fatty Substance	Reaction Observed
Beef Tallow.....	Mild Reaction.
Lard.....	Do.
Lauric Acid.....	Vigorous Reaction.
Fish Oil.....	Mild Reaction.

Example IX

To illustrate the effect of removal of surface diffusion layers formed in accordance with the present invention, a 12" length of $\frac{3}{32}$ " diameter iron wire which had been coated by successive immersion in molten sodium hydroxide and stearic acid and passed through an 18" x $1\frac{1}{2}$ " diameter tubular furnace maintained at 1475° F. is placed in a jet of 250 p. s. i. g. steam. By such treatment the coating is substantially all removed.

Example X

A further experiment is conducted by placing a drop of room temperature water on a length of wire treated with molten sodium hydroxide and molten stearic acid. Examination under a microscope reveals that the surface diffusion layer softens under the influence of water and can then readily be removed by wiping. Toluene and carbon tetrachloride are applied in the same manner as the drop of water to an identical coating without appreciable solvent effect.

Example XI

A 40-foot length of $\frac{3}{32}$ " iron wire previously conditioned in accordance with the process of this invention by successive immersion in molten sodium hydroxide and molten stearic acid and baking at an elevated temperature is given a 54% reduction from 0.0915" diameter to 0.062" diameter in four passes through wire drawing dies at a speed of 80 feet per minute. The intermediate die sizes and the percent reduction for each pass are as follows:

	Percent
0.0825".....	19
0.075".....	25
0.070".....	14
0.062".....	25

The appearance of the surface of the wire coating improved after each draw and the finished 0.062" diameter wire retained a uniform coating.

To illustrate the use of lubricant additives to the molten fatty substance, the following series of experiments are conducted. Samples of iron wire are pickled in HCl at room temperature, rinsed, dried, heated to dull red heat in a nitrogen atmosphere and immersed in molten sodium hydroxide maintained at a temperature of 932° F. The samples of the thus-treated wires are then separately immersed in a second molten bath comprising stearic acid and one of the following additives, the indicated percentage being by weight of the stearic acid, and thereafter passed through a tubular furnace maintained at 1832° F. at a rate sufficient to cause only the removal of unreacted stearic acid and an improvement in the surface of the diffusion layer without appreciable heating of the wire itself.

5% mica powder (160 mesh)

50% powdered graphite (Acheson "Electric Furnace"

Graphite grade 38—National Carbon Co., Inc.)

5% powdered graphite (Acheson "Electric Furnace"

Graphite grade 38—National Carbon Co., Inc.)

In each instance, no apparent reaction of the additive with the stearic acid was noted and the resultant coating was smooth and homogenous. The baking treatment provided a hard, thin, adherent surface diffusion layer. It will be appreciated, thus, that in addition to the other advantages hereinbefore set forth, the present invention affords an excellent means for binding graphite, even a large amount of graphite, on a wire prior to drawing.

Throughout the specification and claims, in stating that the alkali metal hydroxide is employed in the molten state, it is meant that its temperature may range from the temperature at which the particular alkali metal hydroxide or mixtures thereof become molten, to a temperature limited by the boiling point of such hydroxides. However, as a practical matter, the temperature, which, of course, may be varied within this range, depending upon the particular application, is the lowest which provides the desired effect on the metal being treated. Typically practicable temperatures, using sodium hydroxide, are within the range from its melting temperature, i. e., 318.4° C. (606.1° F.), to about 510° C. Similarly, the temperature of the second molten bath also may range from the melting point to the boiling point of the substance or mixture employed, or higher if a vapor phase reaction is desired, although generally temperatures as low as possible within this range are employed. Using stearic acid, typically practicable temperatures within the range from 250°–310° F., although temperatures as high as 375° F. have been used.

The speed at which wire is passed through the molten baths and heat treating furnaces can be varied widely and is dictated by the type of wire being processed and the particular application intended. However, in small-scale installations employing temperatures of the order indicated hereinbefore, lineal speeds within the range from 10 to 20 feet per minute are typical. It is appreciated that commercial wire drawing operations involve wire speeds often as high as several hundred feet per minute. For example, stainless steel wire drawing speeds generally range from about 80 to 200 feet per minute, while carbon steel wire is often drawn at speeds as high as 500 to 600 feet per minute. Hence, it is generally more practicable to treat wire in accordance with this invention and then separately to draw the treated wire. However, in certain instances, continuous drawing operations wherein wire is first treated by the technique of the present invention can

be achieved by proper selection of bath compositions, temperatures, and wire drawing speeds.

Metals which can advantageously be treated in accordance with this invention include both ferrous and non-ferrous metals and alloys. Illustrative are various irons, steels, including stainless steels, titanium, copper, nickel, cobalt, as well as various alloys containing these or other metals or alloys. Moreover, while the invention has been described with particular reference to wire drawing, it will be understood, of course, that other metal operations are contemplated as well, e. g., tube drawing, pressing and stamping in suitable dies, deep drawing of sheet metals, wire rolling, and the like.

While this invention is applicable in a variety of metal treating operations, those skilled in the art will recognize that it provides an improved method for wire patenting, i. e., heat treating of wire, generally medium or high carbon steel wire, before drawing or between draws, whereby the wire is heated above its transformation temperature range and then cooled to a temperature above this range. Wire patenting operations heretofore generally have involved successively passing wire through molten lead, acid pickling, lime slurry soaking, lime baking, and subsequent application of a lubricant. In accordance with the method of the present invention, the patenting can be accomplished directly by successive immersion of the wire in molten caustic and a molten fatty acid or other fatty substance as indicated hereinbefore, without resort to a multiplicity of elaborate and relatively costly operations as heretofore required.

While particular reference has been made herein to the conditioning of wire continually passing as individual strands or filaments through the molten baths, it will be appreciated that the practice of this invention is particularly advantageous in the treatment of coils of wire, tubing and the like. In many instances, depending on the application, such coils need not be unwound but may be treated in coil form.

It is to be understood that although the invention has been described with specific reference to particular embodiments thereof, it is not to be so limited, since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

What is claimed is:

1. A metal treating process comprising the steps of successively immersing the metal in molten alkali metal hydroxide, immersing said metal in a molten fatty substance which reacts with said hydroxide in situ to form a lubricant layer, and subsequently subjecting the thus-treated metal to heating at an elevated temperature sufficient to remove excess unreacted molten fatty substance without removing said lubricant layer.

2. The process of claim 1 wherein said metal is subjected to drawing following removal of the excess molten fatty substance.

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