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COMPOSITION FOR USE IN PREPARING METAL FOR A DEFORMING OPERATION AND METHOD OF DEFORMING

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This invention relates to the art of deforming metal and is particularly concerned with the provision of an improved composition for use in this art as well as to an improved method. We treat and prepare the surface of a metal piece prior to mechanically working the same by such operations as are involved in drawing, rolling, stamping or otherwise altering the physical shape of the piece.

The invention is especially useful in the treatment and working of ferriferous metals and will be described with this specific field of usefulness in mind.

The mechanical working of ferriferous metal articles by processes that are known as "cold" processes has come to be of steadily increasing importance and many of such processes include the step of producing on the metal surface a crystalline phosphate coating followed by the application thereto of various lubricants prior to the actual step or steps of deformation. As is well known in the art, where such phosphatizing procedures have been employed, it has generally been customary to make use of solutions which produce on ferriferous surfaces relatively heavy non-metallic coatings consisting principally of zinc or manganese phosphate. Subsequent to this step, it has heretofore been necessary to rinse the phosphatized surface and then to impregnate the rinsed surface with lubricant prior to the actual deforming operation. This procedure, of course, results in a somewhat laborious multi-step process, the usefulness of which has been severely limited in certain fields of activity, especially in plants or mills which are designed for relatively high speed manufacturing procedures or where limited space is available.

With the foregoing in mind, the principal objects of our invention will be better understood and they may be said to involve the provision of new compositions for use in treating a metallic surface prior to the actual deforming operation, which compositions materially shorten the time involved without in any way sacrificing the many advantages incident to the previous but somewhat more laborious procedures which, heretofore, as stated, have involved the steps of initial phosphate coating, rinsing and final lubrication prior to deformation. Another object of our invention is the provision of a lubricated crystalline phosphate coating for the purpose described, which coating is less susceptible to being stripped from the surface during the deforming operation which, of course, gives rise to a marked advantage in the fact that it affords a safety factor in the maintenance of a continuous lubricant film, thereby mitigating the possibility of damage either to the article being deformed or to the die or other tool being used in the deforming operation. Additionally, our invention makes it possible to subject the article to a series of deforming operations with less necessity for frequent rephosphatizing and lubricating operations. A still further object is to reduce the power required to accomplish a given deformation.

The foregoing, together with such other objects as may appear hereinafter or are incident to our invention, are

attained by means of the invention now to be described. We have discovered that certain saturated fatty acids having at least 12 carbon atoms may be emulsified in an acid phosphate coating bath without in any way interfering with the deposition of the crystalline phosphate coating on the metallic surface. Examples of such acids are stearic, myristic, lauric, palmitic, etc. This makes it possible to provide a bath by means of which simultaneous phosphatizing and lubrication of the metallic surface may be accomplished as a one-step procedure. The straight chain, fatty acids may be used by themselves or in conjunction with their glycerides for certain special purposes which will be pointed out hereinafter.

Briefly stated, our invention involves the use of a conventional acid phosphatizing bath (preferably, although not necessarily, a zinc or manganese phosphatizing bath), which bath may or may not contain accelerators and which has emulsified therein from 0.10 to 5% (weight/volume on the conventional grams/100 cc. basis) of a saturated straight chain fatty acid having at least 12 carbon atoms. Phosphatizing baths capable of producing a crystalline phosphate coating, of course, are very well known to the art and need not be particularly described. In our invention the fatty acids are emulsified therein generally by adding to the bath an amount of an emulsifying or dispersing agent, either non-ionic or cationic in character, sufficient to disperse the fatty acid in the bath at the temperature of normal operation. Such emulsified baths have been found to impart to ferriferous metal surfaces a crystalline phosphate coating while simultaneously impregnating the coating with the lubricant in such fashion as to result in a surface having optimum lubricity when subsequently dried and subjected to mechanical deformation.

According to the practice which we prefer, the quantity of lubricant emulsified in the bath lies between 0.25 and 1% (weight/volume on the conventional grams/100 cc. basis). Such quantity, we have found, produces exceptionally good results because at concentrations of lubricant of over 1%, there is sometimes a tendency for the phosphate coated surface to be so impregnated with lubricant that there may be a build-up of lubricant on the die or other tool. This is not always true for some reason or other but we have found by experience that a 1% upper limit is generally preferable. On the other hand, at lubricant concentrations of less than 0.25%, the phosphate coated surface may not have the maximum lubricity desired for certain deforming operations and, at concentrations of less than 0.10% of lubricant, the lubricity of the coatings falls off markedly. At concentrations greater than the 5% of lubricant, mentioned above as a maximum, there may be an interference of the lubricant with the formation of satisfactory phosphate coatings. While our preferred practice is to employ either zinc or manganese phosphatizing solutions, as indicated above, yet it should be noted that any acid phosphatizing solution which is capable of producing a crystalline phosphate coating on the metal surface may be employed.

With our invention it is sometimes desirable to add to the bath glycerides of the fatty acids employed. The reason for this is as follows. In certain difficult operations, such as upset drawing, contrary to prior practice, the dies will run so cold, because of the high degree of lubricity imparted to the metal by our invention, that the presence of glycerides, by virtue of their relatively low melting point, will permit the part being deformed to be easily ejected even when cold. Where use of glycerides is indicated we prefer to replace a portion of the fatty acid with the glyceride and this can be done up to approximately 25% of the fatty acid.

By way of specific example, the present invention may

be carried out in the following way. First, a typical concentrated phosphatizing composition may be prepared as follows:

Formula A

Zinc oxide	pounds	2.43
Phosphoric acid, 75%	gallons	0.263
Nitric acid, 56.5%	do	0.426
Water, to make 1 gallon.		

A phosphatizing bath may be prepared from the foregoing by dilution with sufficient water to make a conventional 3% by volume phosphatizing bath and this bath, of course, will be nitrate accelerated because of the presence of the nitric acid.

Next, an emulsion of the following formula is prepared:

Formula B

Stearic acid	10% weight/volume.
Polyoxyethylene lauryl alcohol (Brij 35)	10% weight/volume.
Tallow	1% weight/volume.
Water	79%.

Sufficient of the foregoing lubricant emulsion composition is then added to such a phosphatizing bath in a quantity which will yield approximately a 1% concentration of the lubricant emulsion in the bath. The piece to be treated and deformed is then subjected to the action of such an emulsified bath. The solutions may be used in any conventional manner, i. e., in dip baths or in spray processes or in any other way by means of which the surface of the metal is thoroughly contacted with the liquid for a sufficient length of time to allow for the formation of a crystalline phosphate coating. The time involved will depend, of course, upon the temperature of the bath and other factors familiar to those skilled in the art of phosphate coating but, as a general rule, a satisfactory coating will be produced in anywhere from one to five minutes. When the phosphate coating is formed it will be found that the lubricant will have acted thereon to form the lubricated surface desired.

After removal from contact with the solution, it is necessary to dry the coating before proceeding to the deforming operation. As a general rule, we prefer to adjust the temperature of the drying operation so that the lubricant will not melt and run because over-heating and running of the lubricant may cause the surface to lose some of its lubricity. However, experiments have indicated that even in the case of over-heating, the coating still has more lubricating value than it would have had had the object been treated according to prior practice, namely, to an initial phosphate coating step followed by a lubricant impregnation step.

As stated previously, any acid phosphatizing solution capable of producing a crystalline phosphate coating may be used. One of the most simple baths of this nature prepared to embody our invention is as follows:

Formula C

	Pounds
Emulsifying agent	0.15
Stearic acid	0.15
Phosphoric acid, 75%	0.15
Water	0.55
	1.00

A concentrate is prepared according to the above formula by mixing the emulsifier and the stearic acid with the application of heat at approximately 150° F. When thoroughly mixed, the phosphoric acid and the remaining water are added and the admixture is stirred until cool. A suitable operating bath may be prepared from such a concentrate by dilution with 9 to 11 parts of water. Metal treated in such a bath for approximately five minutes' immersion at 150° F. will be found to have had produced

thereon a highly satisfactory lubricated crystalline phosphate surface having the advantages of the present invention.

In order to compare the results attained with our invention with the results which are characteristic of prior practice, work was treated and deformed in accordance with the foregoing instructions and exactly similar pieces were first treated in a bath prepared from Formula A, as given above, after which the pieces were subjected to the lubricating emulsion of Formula B. In other words, the two-step procedure of the prior art was contrasted with the one-step procedure of our invention. Furthermore, various other conventional phosphate coating baths were employed in treating metal pieces, both in accordance with prior practice and in accordance with the present invention. In all instances, the results obtained with the present invention were markedly superior to the results attained by prior practice. Pieces processed and deformed in accordance with our invention were less susceptible to having the coating stripped from the surface being deformed and repeated deformation operations were possible without the necessity of rephosphatizing and relubricating as frequently as such steps have been necessary in the prior art. Furthermore, damage to the article itself or to the die or other tool was noticeably diminished. It was also determined by suitable tests wherein the power necessary to draw a steel bar through a die was measured, that the drawing operation could be performed in accordance with our invention with materially less force than was required where the practice of the prior art was followed. Just why this should be is not fully understood but the fact remains that it constitutes an additional advantage accruing from the use of our invention.

In addition to the advantages already noted, it is obvious that our invention will result in a saving in operating costs.

The emulsification can be accomplished in any desired manner familiar to those skilled in the art of emulsification. In addition to the use of either non-ionic or cationic emulsifying or dispersing agents, as mentioned above, certain more modern ultrasonic techniques may be availed of, if desired. In other words, the manner in which the emulsification is accomplished is not critical and the appended claims are not to be construed as being limited in this respect.

We claim:

1. A metal coating bath consisting essentially of an aqueous acid phosphate solution capable of producing a crystalline phosphate coating on the surface of the metal, said bath having emulsified therein, as an addition agent, from 0.10 to 5% (weight/volume on the conventional grams/100 cc. basis) of a saturated straight-chain fatty acid having at least 12 carbon atoms.

2. The bath of claim 1 where the phosphate of the bath is chosen from the class of zinc and manganese.

3. The bath of claim 2 where the quantity of fatty acid lies between 0.25 and 1%.

4. The bath of claim 1 in which not over 25% of the fatty acids is replaced by glycerides of such fatty acids.

5. In the art of deforming a metal piece by a drawing operation or the like, the method which consists in treating the surface of the piece with a bath consisting essentially of an aqueous acid phosphate solution capable of producing thereon a crystalline phosphate coating, said bath having emulsified therein, as an addition agent, from 0.10 to 5% (weight/volume on the coventional grams/100 cc. basis) of a saturated straight-chain fatty acid having at least 12 carbon atoms, continuing the treatment until a phosphate coating has been produced; drying the piece; and then deforming the same.

6. The method of claim 5 in which the temperature of drying does not exceed the melting point of the fatty acid.

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