A lubricant composition and system for use in hot forming of metals, such as forgings, pressings, extrusions, tube drawings, piercings and wire drawings. The composition comprises a suspension of exfoliated vermiculite particles in an organic film forming liquid composition, with the film forming composition being partially absorbed by and contained in the interplatelet spaces of said vermiculite particles. The organic film forming composition is either water soluble, water emulsifiable or non-aqueous.

23 Claims, 3 Drawing Figures
WATER SOLUBLE SYSTEM

VERMICULITE

LIGNIN SULFONATE

WORKING AREA

% BY WEIGHT OF LIGNIN SULFONATE

% BY WEIGHT OF VERMICULITE

FIG. 1
WATER EMULSIFIABLE SYSTEM

% BY WEIGHT OF VERMICULITE

VERMICULITE

ACRYLIC EMULSION

WORKING AREA

% BY WEIGHT OF ACRYLIC EMULSION

FIG.2
NON-AQUEOUS SYSTEM

VERMICULITE
PARAFFINIC PETROLEUM OIL
WORKING CURVE

% BY WEIGHT OF VERMICULITE

% BY WEIGHT OF PARAFFINIC PETROLEUM

FIG. 3
HOT FORMING LUBRICANT COMPOSITION, SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

The present invention pertains to a new and novel system and method for hot forming of metal parts and employs a new composition which may be formulated to be water soluble, water emulsifiable or non-aqueous. The hot forming contemplated is in the making of forgings, pressings, extrusions, tube drawings, piercings and wire drawings all of which are usually performed at temperatures in excess of 700° F. and, specifically in the range between 600° F. to 3000° F. The lubricant system is primarily intended for use in the production of forgings or pressings, and in particular, in the forming of ferrous metals, high temperature metals and high temperature alloys.

The production of a hammered or pressed forging is accomplished by taking a hot slug or a hot partially shaped part and squeezing or hammering the slug between two dies. The pressure exerted on the slug causes the flow of hot metal over the surface of the die and into the cavities provided therein. The application of pressure is for a very short period of time or in successive short increments so that there must occur an almost instantaneous flow of metal in order to produce the desired shape of the metal article. If this procedure were to be attempted without proper lubrication, the surface of the die and the slug would tend to adhere to one another. More particularly, the frictional forces between the two parts would prevent proper filling of the die and the die recesses.

The combination of heat and pressure has a tendency to weld or fuse two bare or improperly lubricated metal surfaces together, thereby making release of a forged article from within the die extremely difficult and in some instances, impossible. Thus, lubricants must be coated upon the die surface to reduce the resistance to the flow of metal over the die, and to minimize the metal contact between the slug and the die. Another effect of the lubricant is to protect the die surface from wear caused by the projection of hot metal and oxide particles sliding across the die surface at the high pressures employed in these operations. When the surface of the die becomes worn in an irregular or non-uniform manner, which is known as galling, there results a surface which exhibits a high frictional coefficient which then impedes the proper flow of the hot metal.

Hereinbefore, the usual lubricants utilized in hot forming applications have been mixtures of oil, fat and graphite. In view of the fact that present day lubricant compositions and mixtures for high temperature forming have been employed for an extensive period of time, and since insignificant improvements have been obtained, little or no patent literature exists with regard to these simplistic mixtures. However, the use of these type lubricants for hot forming operations at temperatures which may range from 600° F. to in excess of 3000° F., leads to the copious emission of smoke which results from the partial volatilization of the oil from the hot metal surface. Moreover, smoke and dust are ejected during the forging operation, per se. The smoke is caused as a result of the incomplete combustion products of the oil while the dust is comprised of particles of graphite which are ejected from the die surfaces during the forming operation.

Although various water base solutions of graphite or other solid lubricants have been tried, with varying degrees of success, the inherent disposal problems associated with graphite still exist. Attempts at using non-graphitized solid lubricants such as mica and molybdenum disulfide present new problems since these compositions result in unstable lubricant films at the elevated temperatures employed, or fail to carry the frictional load without galling the die surface, or permit accumulation of the solid lubricant particles in the corners of the die. The ecological considerations of present day living render it necessary to provide a non-graphitized heavy duty lubricant which can provide a non-polluting film with all of the attendant desirable qualities of a hot forming lubricant composition.

SUMMARY OF THE INVENTION

Accordingly, it is the primary object of the present invention to provide a new and novel lubricant composition capable of being utilized in hot forming operations which will significantly reduce air and water pollution. It is a further object of the present invention to provide an improved lubricant composition which does not employ graphite particles.

It is still another object of the present invention to provide an improved lubricant composition for use in pressing and forging operations which will be readily and completely dischargeable from the die cavities during the operation and prevent buildup of solid particles in the die which would cause galling and changes of the die tolerances.

It is a further object of the present invention to provide a lubricant composition of the foregoing type which may be readily applied to die cavities by spraying, swabbing, or other current acceptable applying means.

It is yet another object of the present invention to provide an improved lubricant composition which will be low in toxicity so as not to endanger workers or add to present day air and water pollution problems.

It is a particular object of the present invention to provide a lubricant composition comprising a suspension of exfoliated vermiculite particles of predetermined size disposed in an organic film forming compound which is either water soluble, water emulsifiable or non-aqueous.

The use of exfoliated vermiculite particles provides a multiplicity of advantages in the lubricant system. Firstly, the exfoliated vermiculite particles, which are an inorganic pigment, are inherently laminar or platelet and exhibit the typical greasy feel of a solid lubricant, and do not decompose at the elevated temperatures encountered in hot forming operations. Secondly, the porosity or sponginess of the exfoliated vermiculite 20 particles results in the absorption of the organic film forming compound for delayed or time-controlled release of the film forming compound in the forging operation, as will be explained in more detail hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects, features and advantages of the present invention will become more apparent from the description hereinafter when considered in conjunction with the accompanying drawings, wherein:

FIG. 1 is a graph illustrating the possible compositions of a water soluble film forming system for use in hot forming applications, wherein the percentage by
weight of vermiculite is plotted as a function of the percentage by weight of lignin sulfonate:

FIG. 2 is a graph of a water emulsifiable thermoplastic film forming system for use in hot forming applications, wherein the percentage by weight of vermiculite is plotted as a function of the percentage by weight of an acrylic emulsion; and

FIG. 3 is a graph illustrating the possible compositions of a non-aqueous organic film forming system for use in hot forming applications, wherein the percentage by weight of vermiculite is plotted as a function of the percentage by weight of bright stock paraffinic petroleum oil.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention provides a new improved hot forming lubricant composition comprising an organic film forming compound which when subjected to the elevated temperatures of a hot metal slug (e.g., 2250°F.) and the surface of a die, rapidly decomposes and releases large quantities of gases which become compressed and form a film between said hot slug and die surface. The lubricant also contains exfoliated vermiculite particles which serve as immobile nuclei to provide a retardant barrier to prevent the explosive escape of the compressed gases. Thus, the gas layer itself provides increased cushioning in the form of an additional lubricant boundary layer created as the hot slug, via increasing pressure from the hammer or press, is pressed closer to the lubricant covered die surface.

The exfoliated vermiculite itself is a solid lubricant in that it is of platelet construction and provides a laminar lubricant boundary layer which permits the hot slug to flow thereover, thereby preventing galling of the die surface. Moreover, the platelet construction of the exfoliated vermiculite particles renders the same extremely porous or “spongy”, whereby the organic film forming compound is absorbed in the interplatelet spaces. Thus, as the slug passes over the laminar lubricating boundary formed by the vermiculite particles, the particles are compressed and provide a delayed or time-release of the additional organic material stored therein, which thereafter decomposes, in the manner described hereinabove. This action reinforces the previously existing gas boundary layer. It is to be noted that the delayed release of the organic material has a significant effect upon the ability of the formed part to be released from the die, thereby preventing galling of the die surface and extending the die life.

The organic film forming compounds are divided into three groups, as follows:

1. water soluble
2. water emulsifiable
3. non-aqueous.

The water soluble organic film forming compounds must be capable of application upon a hot die or forming tool and also of immediately forming a coherent film with the exfoliated vermiculite particles suspended therein. The foregoing must occur even though the die or forming temperature is above the boiling point of the water used as a solvent or carrier. Specific examples of the materials which may be used as the organic film forming compounds are: lignin sulfonates, either in their modified or purified form, or as the crude derivative of the black liquor from the pulping of wood for the making of paper; sodium gluconates, sodium heptagluconates, cerelose (reducing sugar), polyethylene glycols (preferably those having an average molecular weight in excess of 2000), PVCA (polyvinyl chloride alcohol), the water soluble salts of rosine-maleic and the water soluble salts of styrene-maleic.

The water emulsifiable organic film forming compounds may be selected from the group of emulsions of thermoplastic resins having melting points essentially between 250°F. and 600°F. Specific examples of these types of resin or copolymer resins are: acryl, rosine-maleic, polyethylene glycols, styrene-acrylic, rosin and styrene-maleic emulsions.

Attention is directed to the fact that the foregoing as well as other similarly suitable compounds are commercially available as stable and concentrated emulsion systems.

The non-aqueous organic film forming compounds may be selected from petroleum oils, synthetic lubricating or hydraulic fluids, vegetable oils, fish or animal fatty oils and esters of fatty acids.

While the foregoing list of compounds in each group are exemplary of the materials which may be used in conjunction with the present invention, it is to be noted that combinations of the various compounds within each group may also be employed; and mixtures of the water soluble group and water emulsifiable group may also be employed in order to provide certain desirable film forming characteristics.

Experimentation resulted in the discovery that vermiculite was the proper inorganic pigment to be employed in the present lubricant systems due to the fact that the same was a solid laminar lubricant. Furthermore, the exfoliation of the vermiculite particles, by subjecting the same to heat or certain chemical reactions, causes the particles to assume a platelet structure containing a fibrous and spongy construction between the external laminar platelets.

We have found that the particle size is extremely important and in order that the system work effectively, the size of the vermiculite particles should not exceed 150 microns. The preferential particle size distribution should be one wherein at least 90% of particles are of a size which is less than 75 microns. The optimum particle distribution is one where substantially all of the particles (95%) are less than 50 microns in size.

In the laboratory, experimentation was conducted utilizing a black surface finish, heavy metal plate which was capable of being uniformly heated to preselected temperatures of 325°F. and 450°F. Lubricant compositions were formulated which utilized finely divided, exfoliated vermiculite particles, of the preselected sizes discussed hereinabove, uniformly dispersed in the variously hereinbefore described aqueous and non-aqueous organic film forming compounds. The lubricant compositions were then applied to the heated metal surface by either a uniform swabbing action or by means of a uniform spray. In many instances, both types of application were employed since these application methods closely approximate actual industrial situations encountered in commercial hot forming operations.

It was readily apparent by visual inspection whether or not a lubricant composition had been formed which had a sufficient quantity of the exfoliated vermiculite particles to form a substantially continuous layer. The results of several of these experiments are depicted in the graphs of FIG. 1 through 3. The compositions depicted in the graphs are indicative of the various lubricant compositions which may be used for hot forming
of metal parts and which are capable of application upon dies by presently existent equipment.

With particular reference to FIG. 1, there is illustrated the resultsants of the experimentation, as concerns a water soluble film forming system wherein the various compositions envisioned are graphically depicted. The percentage by weight of the exfoliated vermiculite particles in the composition is plotted as a function of the percentage by weight in the composition of the organic film forming compound which was a commercially available lignin sulfonate compound. A study of the graph reveals that the percentage of the vermiculite particles employed may vary between 0.125 and 25% percent, while the percentage of the lignin sulfonate employed may vary between 2 and 65% percent. It is herein to be noted that for any point chosen on the graph, the remainder of the composition comprises water in combination with small amounts of inerts and thickening agents. An example of an inert is a defoaming agent while one of the thickeners selected may be corn starch.

FIG. 2 illustrates the experimentation results for a water emulsifiable thermoplastic film forming system with the compositions contemplated being graphically depicted. In this graph, the percentage by weight in the composition of exfoliated vermiculite particles is plotted as a function of the percentage by weight in the composition of thermoplastic in the form of a commercially available acrylic emulsion. Inspection of the graph reveals that the percentage of vermiculite particles employed may vary from 0.1 to 30% percent while the percentage of the acrylic emulsion utilized may vary from 0.3 to 40% percent. The remainder of the composition comprises water, inerts and thickeners, as were the compositions in FIG. 1.

FIG. 3 graphically depicts the non-aqueous lubricant systems envisioned by the present invention. In this system, the percentage by weight of vermiculite particles may vary from 1 to 30% percent while the selected oil, which was a bright stock paraffinic petroleum oil, may vary from 70 to 99% percent.

In order to more fully apprise those skilled in the art in the practice of the present invention, there are set forth hereinafter specific examples of the present invention. The following examples were tested in conjunction with the fabrication of metal parts employing hot forming processes. In the following examples, all temperatures are in degrees Fahrenheit and all ratios and percentages are by weight. While the following specific examples are extensive, they are deemed to be merely exemplary of and not limiting of the present invention.

EXAMPLE 1

A lubricant composition of material was formed comprising 6% sodium heptagluconate, 2% exfoliated vermiculite particles and 92% of a water solution containing inerts and thickening agents. The composition was prepared as a uniform dispersion and was applied by means of a pressure spray system to the hot dies in a 4,000 lb. drop hammer which is used to form carbon steel valve bodies. The lubricant composition formed a coherent film on the hot die surfaces. The part was forged from a metal slug which had been heated to a temperature of 2250°F. The lubricant composition exhibited good metal flow and release characteristics in the forming operation and the dies remained smooth and clean. There was no evidence of impaction of the solid pigment or scratching or galling of the die.

EXAMPLE 2

A lubricant composition in the form of a uniform dispersion of material was prepared consisting of 20% of a commercially available grade of lignin-sulfonate, 1.3% exfoliated vermiculite particles and 78.7% of a water solution containing inerts and thickening agents. This lubricant composition was applied by means of a spray in a continuous manner to bare tool steel wire that had been heated to a temperature of 1100°F, such that an essentially uniform coating was produced. The resultant dry coated wire was thereafter continuously drawn through a die on a conventional wire drawing machine while still elevated to a temperature above 1000°F in a manner such that a 20 to 23% reduction in the cross sectional area was produced. The coating applied in the foregoing manner was the only lubricant employed and full drawing speeds were achieved along with excellent surface finish and die life.

EXAMPLE 3

A uniform dispersion lubricant composition was prepared which contained 15% of the alkaline salt of a rosin-maleic copolymer, 4% exfoliated vermiculite particles and 81% of a water solution containing inerts and thickening agents. The lubricant composition was applied to the hot dies of a 6,000 lb. drop hammer used in the forming of three inch stainless steel valve bodies. The lubricant formed a coherent film on the hot die surfaces. The work piece was forged from a slug heated to a temperature of 2300°F. The lubricant permitted excellent metal flow and release during the forming operation while the dies remained smooth and clean with no indication of scratching or galling.

EXAMPLE 4

A lubricant composition in the form of a uniform dispersion was formed consisting of 18% of a commercially available grade of reducing sugar (cervelose), 6% exfoliated vermiculite particles and 76% of a water solution including inerts and thickening agents. The lubricant composition was spray applied to a hot die utilized in the forming of gear blanks. The die operating temperature was in excess of 400°F and a coherent film was formed thereon. The carbon steel slugs employed were delivered to the press at a temperature of approximately 2250°F. The gear blank was formed readily with good release characteristics and there were no visible indications of abrasion or galling of the die surfaces.

EXAMPLE 5

A lubricant composition was prepared consisting of 12% of a commercially available polyethylene emulsion, 6% of exfoliated vermiculite particles and 82% of a water solution containing inerts and thickening agents. A uniform suspension of the lubricant was swabbed upon the hot dies of a 6,000 lb. drop hammer employed in the forging of cone shaped parts from carbon steel slugs. The lubricant composition exhibited good metal flow and release characteristics during the forming operation. The part was readily formed with complete fill of the die cavity and no visible wear, abrasion or impaction of the pigment on the die surfaces were observed.
EXAMPLE 6

A lubricant composition was prepared consisting of 12% exfoliated vermiculite particles, 85% petroleum based lubricating oil (flash point: 565°F, and viscosity SUS 150 at 210°F.), and 3% animal fat. A uniform dispersion of this composition was swabbed on the hot dies of a 6,000 lb. drop hammer used in the forging of cone shaped parts from carbon steel slugs. A uniform film of the lubricant composition was readily formed on the dies and the lubricant exhibited good metal flow and release characteristics with the dies being left bright and clean.

EXAMPLE 7

A lubricant composition was prepared consisting of 25% exfoliated vermiculite particles and 75% of a compounded cylinder oil containing paraffinics and animal fat. A uniform dispersion was obtained and was applied by swabbing to the hot dies of a 2,500 ton press utilized in the forming of axle spindles. The dies were readily coated and the part was formed with excellent metal flow and good release characteristics. The dies exhibited good wear qualities with no scratching or impaction of the solid pigment.

EXAMPLE 8

A lubricant composition was prepared employing 15% exfoliated vermiculite particles and 85% of a mixture of commercially available tall oil and thickening agents. The composition was applied by swabbing to the hot dies of a drop hammer for forming carbon steel bodies and readily formed a uniform film on the die surfaces. The part was formed from a slug heated to a temperature of 2250°F. The lubricant exhibited good metal flow and release characteristics during the forming operation while the dies remained smooth and clean with no evidence of impaction or galling of the die surfaces.

EXAMPLE 9

A lubricant composition was prepared utilizing 30% of exfoliated vermiculite particles, 67% heavy weight bright stock paraffinic oil (flash point: 565°F.) and 3% animal fat. The composition was continuously applied to pickled, bare tool steel wire which had been heated to a temperature of 1050°F. by means of a soap box which preceded the die. The composition formed a uniform film on the heated wire. The wire was thereafter continuously drawn through a die on a conventional wire drawing machine, with the coated wire still at a temperature in excess of 1000°F., whereby a 24% reduction in cross sectional area resulted. The foregoing composition was the only lubricant used and full drawing speeds, together with good surface finish and die life were achieved.

EXAMPLE 10

A lubricant composition was prepared consisting of 4% exfoliated vermiculite particles, 3% hydrogenated castor oil and 93% commercially available oleic acid. The uniform dispersion of the composition was applied by swabbing to the hot dies of a drop hammer used for forming stainless steel valve bodies. The parts were readily formed with good release action. The dies remained clean and there was no evidence of galling of the die surfaces.

EXAMPLE 11

A uniform dispersion of a lubricant composition was prepared consisting of 8% exfoliated vermiculite particles, 89% of a commercial polyalkylene glycol containing thickening agents and 3% animal fat. The composition was applied by swabbing to the hot dies of a press used for forming a cone shaped part from medium carbon steel. The lubricant composition exhibited good metal flow and release characteristics while the dies remained clean and bright with no evidence of galling.

Reference is now had to the following charts which set forth specific examples of the compositions depicted in FIGS. 1 and 2, as used in actual commercial applications.

### CHART 1

<table>
<thead>
<tr>
<th>METAL PART</th>
<th>WEIGHT (LBS.)</th>
<th>PART TEMPERATURES</th>
<th>FORMING PROCESS</th>
<th>METHOD OF APPLICATION</th>
<th>LIGNIN SULFONATE</th>
<th>EXFOLIATED VERMICULITE PARTICLES</th>
<th>WATER SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>Yoke</td>
<td>25</td>
<td>2250°F</td>
<td>Spray</td>
<td>5.34</td>
<td>1.11</td>
<td>93.55</td>
</tr>
<tr>
<td>1040 or above</td>
<td>Brake</td>
<td>150</td>
<td>2250°F</td>
<td>Spray</td>
<td>1.85</td>
<td>0.39</td>
<td>97.76</td>
</tr>
<tr>
<td>Steel</td>
<td>Housing</td>
<td>148</td>
<td>2250°F</td>
<td>Spray</td>
<td>9.6</td>
<td>2.0</td>
<td>88.4</td>
</tr>
<tr>
<td>Steel</td>
<td>Gear Blank with Hammer</td>
<td>12,000 lb.</td>
<td>Swab</td>
<td>9.6</td>
<td>2.0</td>
<td>88.4</td>
<td></td>
</tr>
<tr>
<td>8600 Series</td>
<td>Bearing</td>
<td>25</td>
<td>2250°F</td>
<td>Swab</td>
<td>10.0</td>
<td>2.0</td>
<td>88.0</td>
</tr>
<tr>
<td>8620 Stainless Steel</td>
<td>Ring</td>
<td>12 inch Flange</td>
<td>2000°F</td>
<td>Swab</td>
<td>10.0</td>
<td>2.0</td>
<td>88.0</td>
</tr>
<tr>
<td>304 S.S. Automotive Steel</td>
<td>Crank Shaft</td>
<td>175</td>
<td>1900°F</td>
<td>Spray</td>
<td>6.0</td>
<td>1.2</td>
<td>92.8</td>
</tr>
<tr>
<td>Titanium</td>
<td>Member</td>
<td>2 to 3</td>
<td>1725°F</td>
<td>Spray</td>
<td>16.0</td>
<td>3.3</td>
<td>80.7</td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>Cone Shaped Spindle</td>
<td>22</td>
<td>2250°F</td>
<td>Spray</td>
<td>12.0</td>
<td>6.0</td>
<td>85.50</td>
</tr>
<tr>
<td>Steel</td>
<td></td>
<td></td>
<td></td>
<td>Intermittent</td>
<td>6.0</td>
<td>6.0</td>
<td>88.0</td>
</tr>
</tbody>
</table>
It is thus seen that we have provided new and novel lubricant compositions for use in the hot forming of metals which exceed the performance capabilities of prior art hot forming compositions and which increases the die life. These compositions also have the added desirability of being non-polluting, especially when compared to presently employed graphite lubricant compositions.

It will be apparent to those skilled in the art that while we have delineated numerous specific examples of our invention, that there are many possible changes, modifications and equivalents which may be effected, without departing from the spirit, teachings and scope of the present invention.

What is claimed is:

1. A lubricant composition for use in the hot forming of metals and comprising an organic film forming compound having exfoliated vermiculite particles suspended therein, said exfoliated vermiculite particles having a substantially laminar construction and comprising a plurality of platelet members spaced from one another defining interplatelet spaces, and a portion of said organic film forming compound being absorbed by said particles and disposed in said interplatelet spaces said organic film forming compound being selected from the group consisting of water soluble, water emulsifiable, and non-aqueous compounds.

2. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein said exfoliated vermiculite comprises finely ground particles of predetermined size.

3. A lubricant composition for use in the hot forming of metals in accordance with claim 2, wherein said vermiculite particles are less than 150 microns in size.

4. A lubricant composition for use in the hot forming of metals in accordance with claim 2, wherein all of said vermiculite particles are less than 150 microns in size and at least 90% percent of said particles are less than 75 microns in size.

5. A lubricant composition for use in the hot forming of metals in accordance with claim 2, wherein substantially all of said finely ground vermiculite particles are of a size which is less than 50 microns.

6. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein said organic film forming compound is water soluble and selected from the group consisting of lignin sulfonates, sodium gluconates, sodium heptagluconates, cerelose, polyethylene glycols, polyvinyl chloride alcohol, the water soluble salts of rosin-maleic and the water soluble salts of styrene-maleic.

7. A lubricant composition for use in the hot forming of metals in accordance with claim 6, wherein the amount by weight of the organic film forming compound varies from about 2 to 65% of the lubricant composition.

8. A lubricant composition for use in the hot forming of metals in accordance with claim 7, wherein the amount by weight of the exfoliated vermiculite particles varies from about 0.125 to 25% of the lubricant composition, and the remainder of said composition comprises water.

9. A lubricant composition for use in the hot forming of metals in accordance with claim 8, wherein the water is in the form of a solution containing a thickening agent for increasing the viscosity of the solution.

10. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein the organic film forming compound is lignin sulfonate, and said exfoliated vermiculite particles are of a size which is less than 150 microns.

11. A lubricant composition for use in the hot forming of metals in accordance with claim 10, wherein said organic film forming compound is water emulsifiable and is selected from the group of emulsions of thermoplastic resins having melting points of from about 250°F to 600°F.

12. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein said organic film forming compound is water emulsifiable and is selected from the group of emulsions consisting of acrylic, rosin-maleic, polyethylene, styrene, styrene-acrylic, rosin and styrene-maleic emulsions.

13. A lubricant composition for use in the hot forming of metals in accordance with claim 11, wherein the amount by weight of the film forming compound varies from about 0.3 to 40% of the lubricant composition.

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<table>
<thead>
<tr>
<th>METAL</th>
<th>PART</th>
<th>WEIGHT (LBS.)</th>
<th>PART TEMPERATURE</th>
<th>FORMING PROCESS</th>
<th>METHOD OF APPLICATION</th>
<th>ACRYLIC EMULSION</th>
<th>WATER SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel 1040 or above</td>
<td>Yoke</td>
<td>25</td>
<td>2250°F.</td>
<td>1500 ton Press</td>
<td>Spray</td>
<td>2.78</td>
<td>1.12</td>
</tr>
<tr>
<td>Steel 1040 or equiv.</td>
<td>Brake Housing</td>
<td>150</td>
<td>2250°F.</td>
<td>8000 ton Press</td>
<td>Spray</td>
<td>1.0</td>
<td>.4</td>
</tr>
<tr>
<td>Steel 8600 Gear Blank with Heavy Hub</td>
<td>148</td>
<td>2250°F.</td>
<td>12000 lb Hammer</td>
<td>Swab</td>
<td></td>
<td>4.2</td>
<td>1.66</td>
</tr>
<tr>
<td>Steel 8620 Bearing Ring</td>
<td>25</td>
<td>2250°F.</td>
<td>12000 lb Hammer</td>
<td>Swab</td>
<td></td>
<td>4.2</td>
<td>1.66</td>
</tr>
<tr>
<td>Stainless Steel 12 inch Flange</td>
<td>100</td>
<td>2200°F.</td>
<td>4000 lb Hammer</td>
<td>Swab</td>
<td></td>
<td>5.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Steel 304 S.S. Automotive Crank Shaft &quot;T&quot; Member</td>
<td>175</td>
<td>1900°F.</td>
<td>3000 ton Press</td>
<td>Swab</td>
<td>Spray</td>
<td>2.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Titanium Cone Shaped Spindle</td>
<td>22</td>
<td>2250°F.</td>
<td>3000 ton Press</td>
<td>Spray</td>
<td>Intermittent</td>
<td>2.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>

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14. A lubricant composition for use in the hot forming of metals in accordance with claim 13, wherein the amount by weight of the exfoliated vermiculite particles varies from about 0.1 to 30% of the lubricant composition, and the remainder of said composition comprises water.

15. A lubricant composition for use in the hot forming of metals in accordance with claim 14, wherein the water is in the form of a solution containing a thickening agent for increasing the viscosity of the solution.

16. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein the organic film forming compound is an acrylic emulsion, and said exfoliated vermiculite particles are of a size which is less than 150 microns.

17. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein said organic film forming compound is non-aqueous and is selected from the group consisting of petroleum oils, synthetic lubricating fluids, hydraulic fluids, vegetable oils, fish oils, animal fatty oils and esters of fatty acids.

18. A lubricant composition for use in the hot forming of metals in accordance with claim 17, wherein the amount by weight of the film forming compound varies from about 70 to 99% of the lubricant composition.

19. A lubricant composition for use in the hot forming of metals in accordance with claim 18, wherein the amount by weight of the exfoliated vermiculite particles varies from about 1 to 30% of said composition.

20. A lubricant composition for use in the hot forming of metals in accordance with claim 19, wherein said exfoliated vermiculite particles are of a size which is less than 150 microns.

21. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein said organic film forming compound is water soluble, the amount by weight of said film forming compound varies from about 2 to 65% of said composition, the amount by weight of said exfoliated vermiculite particles varies from about 0.125 to 25% of said composition, and the remainder of said composition is water.

22. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein said organic film forming compound is water emulsifiable, the amount by weight of said film forming compound varies from about 0.1 to 30% of said composition, and the remainder of said composition is water.

23. A lubricant composition for use in the hot forming of metals in accordance with claim 1, wherein said organic film forming compound is non-aqueous, the amount by weight of said film forming compound varies from about 70 to 99% of said composition, and the amount by weight of said exfoliated vermiculite particles varies from about 1 to 30% of said composition.

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