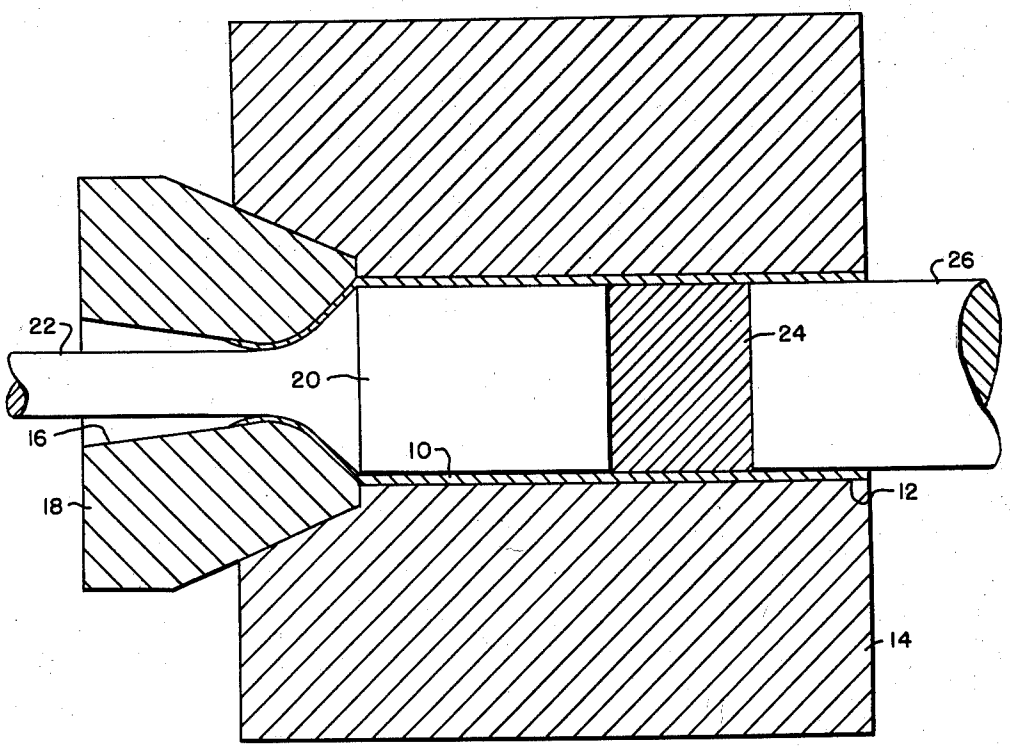
July 9, 1963 R. W. TOMBAUGH 3,096,881

LUBRICATING COMPOSITION AND METHOD FOR THE HOT EXTRUSION OF METALS

Filed Dec. 20, 1956



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United States Patent Office 3,096,881 Patented July 9, 1963

3,096,881

LUBRICATING COMPOSITION AND METHOD FOR THE HOT EXTRUSION OF METALS

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Filed Dec. 20, 1956, Ser. No. 629,635
3 Claims. (Cl. 207—10)

This invention relates to the hot extrusion of metals and particularly to a lubricating composition to be employed in lubricating the surfaces of heated metal billets to facilitate extrusion through or between dies.

Many metals and alloys in use can only be extruded satisfactorily at elevated temperatures. As is well known in the art, many metals, even when highly heated, do not flow and shape readily in the dies of an extrusion press, and require unusually high pressures to produce satisfactory extrusions.

In the hot extrusion of metals, it would be desirable to dispose some lubricating composition between the metal billet and the die. When the metal is deformed by an extrusion operation, it is subjected to a considerable stretching and thinning out action that is accompanied by a considerable flowing of the metal in various directions. This movement of metal takes place under high pressure, and a satisfactory lubricant should control this flow and minimize or prevent metal-to-metal contact between the metal billet and the die.

The lubricating composition employed in the hot extrusion of metals must be incombustible at the extrusion temperature employed and must not be destroyed or otherwise adversely affected in the relatively brief period involved in the extrusion process so as to render it useless as a lubricant.

The object of this invention is to provide a lubricating composition for hot extrusion of metal comprising intermingled finely divided molybdenum disulfide and finely divided lead.

Another object of this invention is to provide for the hot extrusion of metals by employing as a lubricant between a highly heated billet of the metal and the extrusion die a composition comprising finely divided molybdenum disulfide and finely divided lead.

Other objects of this invention will, in part, be obvious and will, in part, appear hereinafter. For a better understanding of the nature and objects of the invention, reference should be had to the following detailed description and drawing, in which the single FIGURE is a cross-section through a portion of a hot extrusion press.

It has been proposed to employ finely divided molybdenum disulfide alone as a lubricant for the hot extrusion of metals. However, when subjected to the high temperatures encountered in the hot extrusion of metal, molybdenum disulfide oxidizes readily and loses its lubricity, and in fact becomes abrasive.

In accordance with this invention, unexpected results have been obtained in lubricating dies, particularly dies employed in the hot extrusion of metals, by applying thereto a lubricating composition comprising intimately admixed finely divided molybdenum disulfide and finely divided lead.

The lubricating composition of this invention is prepared by thoroughly admixing one part of finely divided molybdenum disulfide and from two parts to six parts of finely divided lead, all parts being by volume. The molybdenum disulfide is preferably of a fineness to pass through a sieve having from 100 to 500 meshes per lineal inch and the lead is of a fineness to pass through a sieve having from 50 to 400 meshes to the lineal inch. This mixture can be employed in dry form. However, it is preferred to add to the mixture a suitable organic liquid to

form a paste. Suitable organic liquids that may be employed are the polyalkyleneglycols, such as polyethyleneglycol; liquid polyesters, such as the esters of azelaic acid, adepic acid and the like; glycols; and petroleum oil. Organic liquids having a viscosity of up to 1000 centipoises at 25° C. can be satisfactorily employed, although it is preferred to use those having a viscosity of not above 100 centipoises at 25° C. In paste form, the composition is more easily and readily applied to the surfaces to be lubricated. Pastes having a viscosity of from 200 to 100,000 centipoises at 25° C. have been found satisfactory.

In carrying out the extrusion process of this invention, the surface of the die that makes contact with the metal billet during extrusion is coated with a thin layer of a paste comprising the lubricating composition of the invention. To provide for the most complete lubrication during the extrusion process, it is also desirable to apply a layer of the lubricating composition to the bore of the extrusion container.

The metal billet is prepared for extrusion by heating it to the desired temperature either in a furnace or a salt bath. It has been found that heating the billet in a salt bath in such a manner so as to retain thereon a thin layer of molten salt is a satisfactory procedure. The heated billet is introduced into the bore of the extrusion container and extruded under pressure by applying a ram or plunger to the end of the billet, by conventional methods.

For many metals, it has also been found necessary to heat the metal billet to a temperature of from 1500° F. to 2400° F. At this temperature, the billet, during the extrusion process, readily melts the lead component of the lubricating composition. The molten lead cooperates with the molybdenum disulfide to produce a composition having unusual lubricity. The extrusion container is maintained at a temperature of about 750° F. during the extrusion process so that the heated billet will not cool too rapidly. The molybdenum disulfide exhibits excellent lubricating qualities at these high temperatures when associated with molten lead.

Referring to the single FIGURE of the drawing, there is shown a metal billet being extruded through a die in accordance with this invention. As shown in the single FIGURE, a layer **10** of the lubricating composition of this invention has been applied to a bore **12** of an extrusion container **14** and also to that surface of an opening **16** of a die **18** that makes contact with a billet **20** as it is being extruded to form an extruded member **22**. The portion of the extrusion press shown is conventional, the pressure required to extrude the billet being applied by a ram **26** which may be hydraulically operated. A dummy block **24** is shown positioned between the billet **20** and the ram **26**.

Metals of the following type have been successfully extruded by employing as a lubricant the composition of this invention: uranium alloys such as U–12 Mo, (12% molybdenum—88% uranium); U–10 Nb; uranium alloys of the type U–3.8 Si; and zirconium base alloys. The extrusion of carbon steel, stainless steel and titanium is facilitated greatly by the lubricant of this invention. The surfaces of the extruded members have been practically striation-free. Furthermore, the excellent lubricity provided by the lubricating composition has provided longer life for the extrusion dies than heretofore possible.

Another important feature of the lubricating composition of this invention is that it permits the use of lower extrusion pressures thereby making it possible to increase the reduction in area of the metal billet being extruded.

The following example illustrates the preparation of a thin paste comprising the lubricating composition of this invention:

Example I

Eight parts by volume of lead of a fineness of about 200 mesh was thoroughly admixed with 2 parts by volume of molybdenum disulfide of a mesh of about 230. One part by volume of polyethyleneglycol was thoroughly admixed with this mixture. A paste was formed which had a viscosity of about 5000 centipoises at 25° C.

The following examples illustrate the excellent lubricity of the lubricating composition of this invention in the hot extrusion of metals as compared to other known lubricating compositions.

Example II

On a 500 ton horizontal extrusion press, twenty jacketed billets having a diameter of about 2.55 inches and a length of about 6.5 inches were extruded from a container having a bore of a diameter of 2.6 inches and through a die having a circular opening therethrough of a diameter of 7/16 inch. Prior to each extrusion procedure, the lubricating paste of Example I was applied to the surface of the bore and to the surface of the die opening. Each jacketed billet was heated prior to extrusion to a temperature of about 1900° F. in a molten salt bath comprising, by weight, 85% barium chloride and 15% sodium chloride. The extrusion container was maintained at a temperature of about 750° F. during the extrusion procedure.

The jacketed billets extruded comprised a core of a uranium base alloy comprising, by weight, 88% of uranium and 12% molybdenum; an intermediate layer of a zirconium base alloy comprising, by weight, about 1.4% of tin, about 0.10% of chromium, about 0.06% of nickel, about 0.13% of iron, and the balance being zirconium with incidental impurities, and an exterior layer of mild steel. The diameter of the core was about 1.58 inches, the wall thickness of the intermediate layer was about 0.47 inch, and the wall thickness of the exterior steel layer was about 0.015 inch.

The average starting pressure required for the twenty extrusions was 405 tons. The resistance to deformation K, also termed the extrusion constant, stated in pounds per square inch was 42,800. The resistance to deformation, K is represented by the formula

$$K=\frac{P}{A_o \ln \frac{A_0}{A_1}}$$

where P is the total load on the ram or plunger in pounds, A_0 is the cross-section of the bore of the container in square inches, A_1 is the cross-section of the extruded member in square inches, and *ln* refers to the logarithm to the base *e*.

Example III

The die employed in Example II was replaced by a new die of same size and opening. Twenty-four jacketed billets of the same size and composition of Example II were extruded following the procedure and conditions as set forth in Example II. The lubricating composition, however, was replaced by a lubricating paste comprising finely divided lead alone dispersed in polyethyleneglycol, the viscosity of the paste being about the same as Example I. The average starting pressure required for the twenty-four extrusion was 496 tons. The pressure required to extrude the billets as represented by the extrusion constant K was 52,500 p.s.i. All extruded members were heavily striated.

It will benoted that in Example II there is an 18½% reduction in the extrusion constant K over that of Example III. Such a reduction will make it possible to increase the reduction in area of a billet approximately 100% by the use of the lubricating composition of this invention.

Finely divided graphite dispersed in petroleum oil was also employed as a lubricant for comparative purposes and it was found to be greatly inferior to the lubricant of finely divided lead in polyethyleneglycol employed in Example II.

The lubricants of this invention have proven to be highly superior to any lubricant previously known in the art of hot extrusion.

Since certain changes may be made in the above invention and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description and drawing shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In the method of extruding a metal billet from an extrusion container having a bore therethrough to accommodate the metal billet and a die at one end of the bore, the die having an opening through which the billet is extruded, the steps comprising applying a layer of a lubricating composition consisting essentially of, by volume, 1 part of finely divided molybdenum disulfied and from 2 parts to 6 parts of finely divided lead to the surface of the bore and to the surfaces of the die with which the billet makes contact during extrusion, heating the billet to a temperature of from 1500° F. to 2400° F. and introducing it into the bore of the extrusion container and extruding the billet under pressure.

2. A lubricating composition for use in the hot extrusion of metals, said composition consisting essentially of, by volume, one part of finely divided molybdenum disulfide and from 2 parts to 6 parts of finely divided lead.

3. A lubricating composition for use in the hot extrusion of metals, said composition consisting essentially of one part by volume of finely divided molybdenum disulfide, from 2 parts to 6 parts by volume of finely divided lead, and an amount of an organic liquid sufficient to provide a paste having a viscosity of from 200 to 100,000 centipoises at 25° C.

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