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[54] **DIE PAD FOR EXTRUDING HOT METALS**

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[51] **Int. Cl.**..**B21c 23/32**

[58] **Field of Search**.................72/41, 42, 43, 46, 253

[56] **References Cited**

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2,706,850	4/1955	Sejournet et al.	72/42
2,893,555	7/1959	Buffet et al.	72/42
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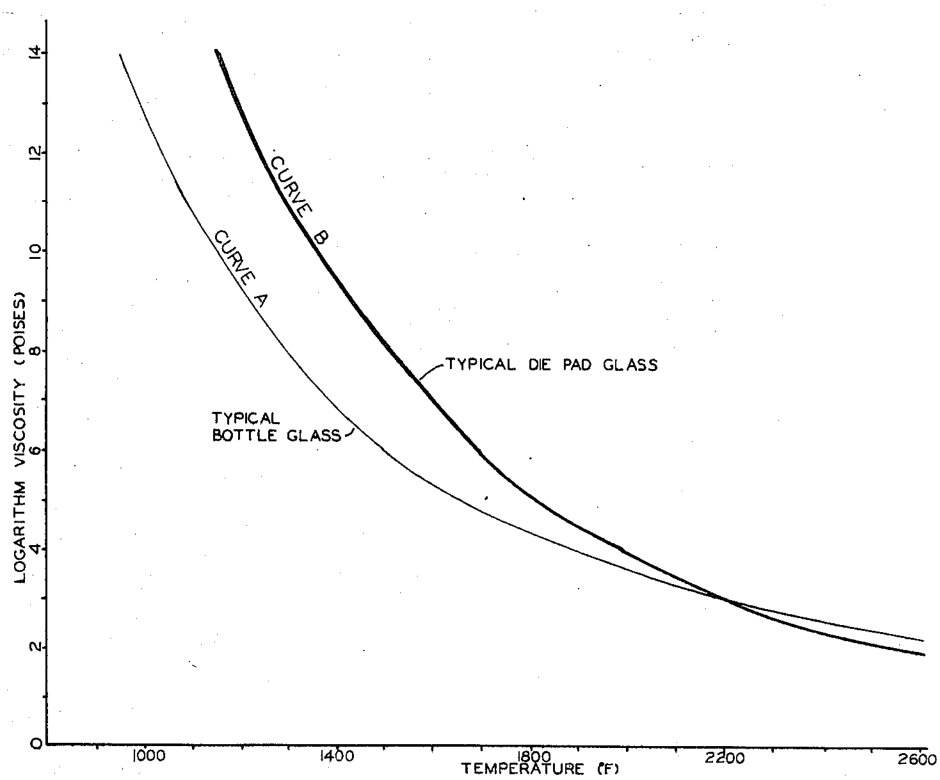
[57] **ABSTRACT**

A die pad for lubricating an extruding die as a metal billet is extruded therethrough comprising felted glass fibers. Particularly advantageous results are achieved with glasses which soften and melt in a narrow range of temperatures near the extrusion temperatures. Omission of organic binders and avoidance of undesirable side effects is possible with felted fibers. Densities in the pads of from 3 to 20 pounds per cubic foot have been employed depending upon the amount of lubricating glass required and the pad thickness acceptable.

10 Claims, 1 Drawing Figure



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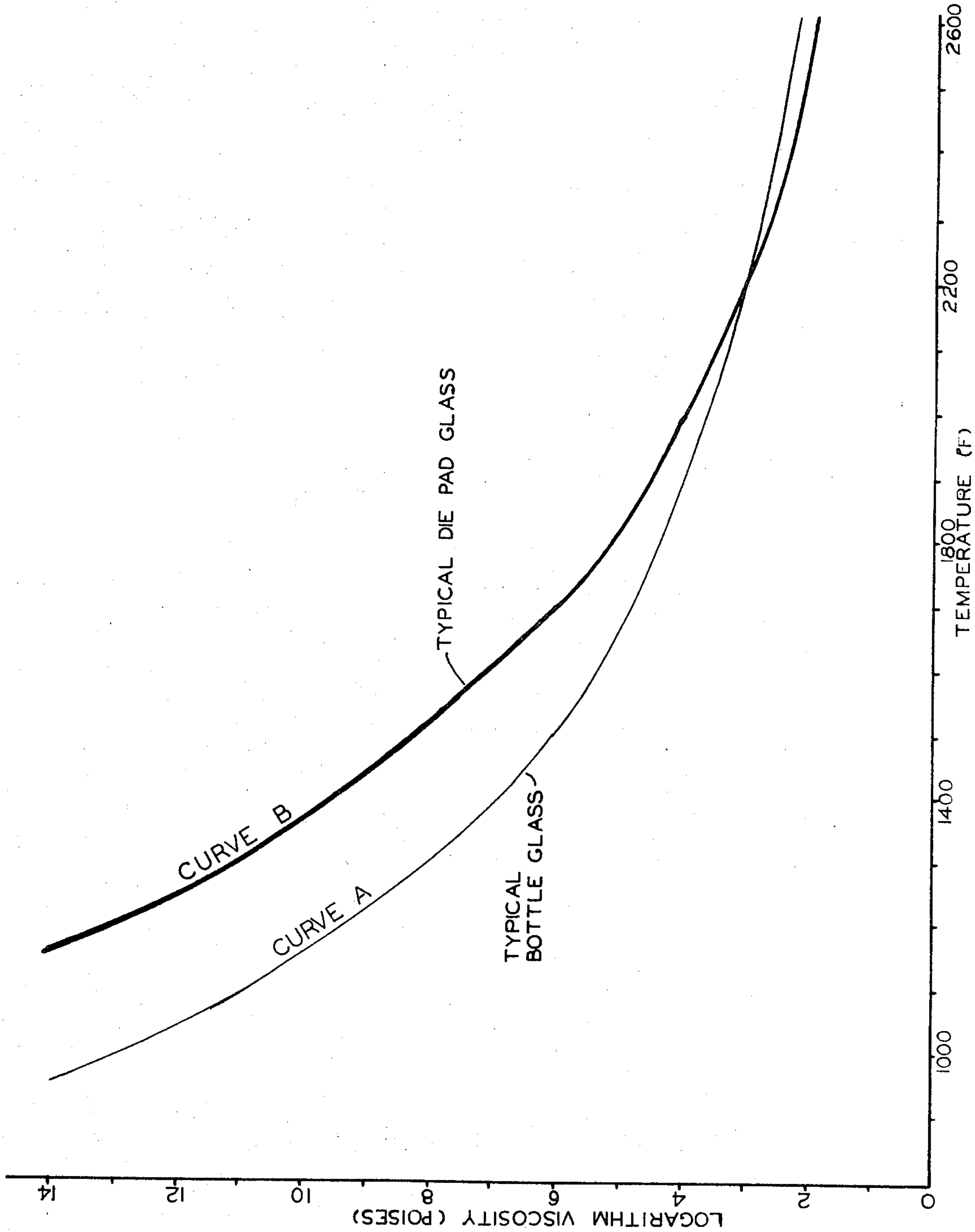

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DIE PAD FOR EXTRUDING HOT METALS

BACKGROUND OF THE INVENTION

The extrusion of hot metals has been facilitated by lubricating the extrusion dies to extend die life and improve the product surfaces. The process involves the rapid advance of a heated billet into a chamber and against a face of the chamber mounting a forming die such that extruded forms are projected therefrom. Because of the necessity of high pressures and temperatures the die, billet chamber and associated equipment are subject to erosion, wear and deterioration. Lubrication of the die has been proposed to decrease the energy necessary for the extrusion, reduce erosion and wear of the die and minimize surface defects in the products obtained.

Fusible materials have been inserted between the billet and die so that the lubricant material is in contact with the billet and continuously melts and flows through the die along the extruded object. Glass plates have been employed both individually and in conjunction with cushioning glass fiber parcels as disclosed in Sejournet U.S. Pat. No. 2,630,220 issued Mar. 21, 1953. Sejournet offered no disclosure of the glass composition constituting the fiber parcel, how the fibers are bonded, or its density and suggested that as the glass plate thickness was reduced, the glass fiber parcel thickness should be increased. Glass in the form of a powder agglomerated by a binder such as sodium silicate into a disc was suggested as a lubricant for extruding hot metals in Edgecombe U.S. Pat. No. 2,946,437 issued July 26, 1960. Labino, in U.S. Pat. No. 3,181,324 which issued May 4, 1965 entitled "Lubricant Pad for Extruding Hot Metals" proposed a matrix of between about 14 percent and 40 percent high temperature fiber such as silica fiber containing finely divided refractory materials such as alumina, zirconia or powdered glass. Labino slurried the fibers and powder and dried it to produce a mat or matrix to form a felt about one-half inch thick.

The aforenoted combinations of fiber and other elements tends to result in discontinuities in the lubrication of the die attributable to differences in the melting temperatures of the several elements. The melting of the powders or other additives at higher temperatures than the glass fibers is believed to tend to reduce die life and impart a poor finish to the extruded pieces due to the initial melting of the fibers prior to the melting of the additive; however, it is to be understood that the speed with which the extrusion process is practiced (a billet about two feet long is extruded in about two seconds), the temperatures and pressures involved, and the lack of accessibility of the region in which the physical changes occur, it is difficult to establish the conditions and transitions during extrusion.

It has been noted that prior lubricant pads having binders or organics that break down on heating, give rise to bubbles in the melted glass and small explosions during the extrusion which appear to cause irregularities in the surface of the extruded product.

SUMMARY OF THE INVENTION

This invention relates to lubricating die pads for extruding hot metal and more particularly to improved pads made up of fibers of one composition, felted to a density of from 3 to about 20 pounds per cubic foot and free of organic binders.

The pads of this invention are formed of fibers of glasses having a viscosity-temperature characteristic such that the softening point, as determined by the fiber method, (viscosity in poises of $10^{7.6}$) is about 1,550° F. and viscosity in poises of 10^3 is about 2,200° F. They are advantageously of fibers which can be produced economically and can range up to 20 microns in diameter produced either as continuous filaments or as blown staple fibers. A suitable balance for felting without additives require some small staple fibers, of the order of 1 to 5 microns average diameter. Further, the fine diameters facilitate the formation of thick felts. A pad composed solely of fibers is also believed to progressively and completely melt from its outer surface inward, thereby progressively supplying a uniform amount of lubricant to the die-billet interface during extrusion.

DESCRIPTION OF THE DRAWING

The drawing represents plots of the logarithm of viscosity in poises against temperature for conventional glasses as employed for container and flat glass fabrication, curve A, and for glasses of the type suitable in fiber form for die pad fabrication according to this invention, curve B.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An effective die lubricating pad should be of proper form, include fibers of desired characteristics, and be composed of a suitable glass.

Pad characteristics desired include an adequate supply of the lubricant for the amount of material to be extruded, a progressive and continuous release of lubricant from the pad to the die-billet interface, and the absence of disruptive bodies in the lubricant at the die-billet interface. Stainless steel extrusions have been produced from billets about two feet long and of the general cross-sectional dimensions of the die pads employed with an extrusion being completed in about two seconds. A significant increase in the number of passes has been attained, using a die pad of this invention for each extrusion as a charge preceding the billet into the extrusion chamber, without appreciable die deterioration.

The quantity of lubricant is determined by the amount of available glass. A preferred pad material has been composed of 6-pound-per-cubic-foot density 2-inches thick. In some instances, the pads are in the form of discs. A family of annuluses have been employed having outer diameters approaching the cross-section of the extrusion chamber, generally in the range of about 5 to 9 inches in diameter, and inner diameters ranging from about 1 ½ to 4 inches.

These pads are formed by dispersing glass fibers in water, using a small amount of mineral acid, such as sulfuric acid, in the water if necessary to aid in dispersing the fiber. The slurry of fiber in water is then filtered through a screen to form a pad, using pressure or suction, if desirable, to attain the desired thickness and density. The wet fiber pad is dried to produce a felted body. While the pads can be cut from felted sheets, it has been found to be economical to cast the pad in the form of a disc or annulus of the final desired dimensions.

Pad dimensions have not been critical although pad density should exceed the minimum specified density. Excessive density is not harmful to the extrusion process, but is uneconomical. Various densities ranging from about three to as high as 20 pounds per cubic foot can be made with glass fibers with no binders used.

While organic binders can burn or char and can create gas that can cause explosions in the confined extruding chamber, inorganic binding agents which will form glassey characteristics at the extrusion temperature at which the pad is to be used, such as colloidal silica or silicate of soda, can be used. Such inorganic binders up to about 5 percent by weight are advantageously employed when the fibers are coarser than about 2 or 3 microns in diameter to improve the handling properties such as packing, shipping, and manipulation in use. Inorganic binders can be added to the aqueous slurry, or to the wet pads as they are formed and before drying. However, improved integrity of pads including coarse fibers also can be achieved by blending finer fibers, e.g. about 1 micron average diameter, into the slurry.

Fiber characteristics are determined by economics and the desired properties in the finished die pads. Fine fibers tend to give a thicker and tougher product, but are more expensive to produce for a given weight of glass. They also reduce the speed with which water can be removed in the pad formation process and thus the production rate. Staple, blown glass fibers containing a range of diameters useful in a felting type of pad formation, e.g. about 1 to 1.5 microns average diameter, are suitable to form a pad of the desired integrity and strength. The use of coarser, continuous filament type fibers provides a product with higher density but with less integrity and strength.

Continuous monofilament glass fibers ranging in size up to about fifteen microns in diameter can be employed in the slurry following its reduction in length by milling in a hammer mill or otherwise mechanically breaking it into lengths which will dispense uniformly and felt conveniently. Lengths up to one-half inch for the milled continuous filament fibers of 10 to 15 micron average diameter in satisfactory. These monofilament lengths can constitute up to 80 percent by weight of a felted pad containing no binder provided the remainder of the fibers are staple fibers of about 1 to 1.5 microns average diameter while maintaining commercially acceptable handling characteristics. At greater than 80 percent by weight of the milled monofilament the pad is effective as a die lubricating element but must be handled so carefully in packaging, shipping, unpackaging and loading in the die as to require near laboratory conditions. In this combination the slurry can be formed into a high density finished die pad with good water draining properties, and good integrity and handling properties. It is to be understood that the proportions of coarse and fine fibers can be adjusted for economic considerations and desired physical properties so that the greater the proportion of fine fibers, the thicker and tougher the pad, while the greater the proportion of coarse or continuous filaments, the greater the density of the pad.

The variations in pad structure with the variations in the blend of glass fibers will be appreciated from the table which follows wherein the blown staple fiber in wool form of an average diameter of 1.3 microns and, when present, the continuous filament or textile fiber of about 15 microns diameter milled to lengths no greater than about one-half inch has been thoroughly dispersed by a beater type aggitator. Under such processing, particularly where the acqueous solution is slightly acidic, the clumps of wool are separated into a smooth slurry which can be maintained uniform in its fiber composition until it is cast to its felted form. Such casting can be in a tube of circular cross-section having an inner diameter corresponding to the outer diameter of the pad. A cylinder can be concentrically mounted in the tube to define the inner diameter of the annulus pad form. A force of from about 50 to 100 pounds can be imposed on the upper surfaces of the wet slurry during the extraction of water therefrom to in-part reduce the pad thickness. However, it is to be understood that the force can not be so great as to fracture the individual fibers in any substantial degree or the resulting pad will be excessively fragile. Typical pads made with no binder by the above felting process are as follows:

Blown fiber 1.3 micron (gms.)	Milled Continuous filament 15 micron (gms.)	Thickness of Pad (inches)	Density (pound per cubic foot)
	Pad 5¾ inch O.D. 1½ inch ID		
76	0	2.2	5.8
50	38	2.0	7.0
	Pad 8⅝ inch O.D 1½ inch ID		
300	100	3.5	7.2
240	200	3.0	9.4
230	200	2.9	9.7
340	200	3	11.7
260	600	3.7	15.0
25	600	2.5	15.8

The relationship of thickness and density of the pads illustrates the tendency of a preponderance of finer fibers to produce thicker pads which are tougher than the same density pad in which the heavier fibers are in greater proportion.

It is important that the glass soften and flow as a viscous liquid at the proper temperatures. It should soften from a rigid state to a fluid state rapidly so that a steady supply of molten glass is formed at the outer surfaces of the pad and flows onto the forming die surface to accomplish the desired protection and lubrication. Thus, as the hot metal is moved through the die under pressure, it entrains a thin film of melted glass which is carried to the die-workpiece interface to facilitate flow and improve the extruded finish.

For stainless steels and other metals worked at about 2,000° to 2,300° F. a glass with viscosity-temperature characteristics shown in the drawing is desirable. The glass must have suitable properties to enable commercial melting and practical, economical fiber forming characteristics so that a usable fiber can be made at a reasonable cost. A number of glasses are known to offer these properties. Typical glasses suitable for this use are disclosed in the following U.S. PatS., each entitled "Glass Composition": 2,334,961 to R. A. Schoenlaub, issued Nov. 23, 1943; 2,571,074 to R. L. Tiede and F. V. Tooley, issued Oct. 9, 1951; No. 2,681,289 to L. D. Moore, issued June 15, 1954; and No. 3,053,672 to D. Labino, issued Sept. 11, 1962. "E" glass has the fiber forming and softening point and melting characteristics desired. Suitable glasses can be formulated in the range by weight:

Silica (SiO_2) 50 to 58 percent
Boron Oxide (B_2O_3) to 10 percent
Alumina (Al_2O_3) to 15 percent
Calcium or in-part Barium Oxide (CaO or BaO) to 25 percent
Potassium or Sodium Oxide (K_2O or Ha_2O) 0.5 to 6 percent

Glass modifications with various oxides or other glass making components are acceptable as long as the general viscosity and temperature relationship wherein the glass resists softening until the working temperature of the metal is approached yet at the working temperatures and pressures, it melts rapidly.

Generally commercial glasses employed for containers and flat glass have a viscosity-temperature relationship as shown by curve A on the graph. While the glasses begin to soften at a lower temperature than the type of glass desired for die pads according to this invention, curve B, their change in viscosity per increment of temperature is much smaller than for the glass of curve B and thus they require higher temperature to reach a suitable fluid state than do the lubricating glasses typified by curve B. The glasses of curve A do not provide a uniform constant film of glass under the time and temperature relations found in hot metal extruding, with the result that surface imperfections occur on the extruded products and die life is greatly reduced.

The combination of a suitable glass composition and proper blending of fibers into a felted die pad has enchanced product properties and extended die life for hot extrusion of steel alloys and titanium alloys in the range of about 2,000° to 2,300° F. The glass appears to melt more consistently from fine fiber form than with granular or bulk glass either exclusively or in combination with fibers. Further, the elimination of organic binders and the use of glass felting techniques to maintain the fibers in the pad improves the results by avoiding disruptive foreign matter and gases at the die-workpiece interfaces.

It is to be understood that a wide range of glass compositions can be employed for the fibers incorporated in the die pad of this invention provided they soften close to and below the temperature and pressure conditions to which they are subjected during extrusion of the hot metal for which they are intended and provided they are sufficiently fluid to flow to the surfaces to be lubricated at the extrusion pressure and temperature. Various combinations of fiber sizes can be employed depending on the characteristics desired as to amount of lubricant needed and thus density of the pad for a given pad size, the economics of pad production, and the amount and nature of the physical stresses to which the pad will be subjected prior to extrusion of the hot metal. While pads of felted fibers having no binder have advantages over pads requiring a binder, small amounts of inorganic binder can be employed where that binder becomes glassey in the extrusion step. In view of the variations, combinations and trade-offs of characteristics available for pads according to this invention, it is to be understood that the detailed disclosure is to be read as illustrative and not in a limiting sense.

What is claimed is:

1. A die pad comprising a self sustaining body shaped to fit within a die cavity through which a billet of hot metal is to be extruded, said body having a density between 3 and 20 pounds per cubic foot comprising at least 95 percent by weight of siliceous fibers felted from a slurry and of compositions having essentially the same softening and melting characteristics and free of organic binders, at least 20 percent by weight of said fibers having an average diameter of about 1 to about 5 microns and up to 80 percent by weight of said fibers having an average diameter from about 10 to about 15 microns.

2. A pad according to claim 1 wherein said siliceous fibers are of a composition which softens at about 1,550° F. and has a viscosity of 10^3 poises at about 2,200° F.

3. A die pad according to claim 1 wherein said fibers having an average diameter of about 1 to about 5 microns are staple, blown glass fibers.

4. A die pad according to claim 1 wherein said fibers having a diameter of from about 10 to about 15 microns are derived from continuous microfilament fibers.

5. A die pad according to claim 1 wherein said fibers having an average diameter of from about 10 to about 15 microns are preponderant.

6. A die pad according to claim 1 wherein said fibers are dispersed uniformly in the felted pad.

7. A die pad according to claim 1 including up to 5 percent by weight of an inorganic binder.

8. A die pad according to claim 7 wherein said inorganic binder is of a material which becomes glassy at temperatures above 1,500° F.

9. A die pad according to claim 7 wherein said binder is solely of siliceous materials.

10. A die pad according to claim 1 wherein said fibers are of staple, blown glass of a composition which softens at about 1,550° F. and has a viscosity of 10^3 poises at about 2,200° F. which are interlocked into a unitary annular body of about 6 pounds per cubic foot density.

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