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EXTRUSION DIE LUBRICATION

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1 Claim. (Cl. 207—17)

This invention relates to improvements in the extrusion of metals and is concerned particularly with arrangements for lubricating a billet as it is forced through an extrusion die. By improvements in lubrication, wear in the extrusion die is reduced and the surface finish and dimensional control of the extruded product is improved.

Particularly in the hot extrusion of large steel rods or tubes, difficulty is experienced in providing satisfactory lubrication of extrusion dies and billets since, under the very high temperatures involved in making the extrusion, the lubricant tends to become very fluid and leaches through the die during the first phase of extrusion. If the extrusion is a long one, most of the lubricant is exhausted for the last part of the extrusion pass. Inadequate lubrication permits excessive wear in the extrusion die and consequent inferior finish of the surface of the article being extruded.

Many attempts have been made to improve this condition by utilizing lubricants of different characteristics, even going so far as using glass as a lubricant. But thus far, none of them seem to attain the desired effect. This invention provides an arrangement for controlled lubrication of the billet as it passes through the extrusion die, so that a supply of appropriate lubricant, placed in the die cavity before the extrusion begins, will be fed progressively to the entering region of the die and will last for the entire extrusion pass.

Objects of the invention are to improve the technique of extrusion die and billet lubrication and to provide a specific system to attain optimum lubrication for an extrusion.

The specific provisions of this invention are explained in detail in the following specification and are illustrated in principle in the attached drawings, in which:

Fig. 1 is a longitudinal section through portions of an extrusion press incorporating the features of the invention,

Fig. 2 is a section on the line 2—2 of Fig. 1, and

Fig. 3 is an enlarged detailed view of a portion of Fig. 1, showing an extrusion in process.

In the drawings, the components of an extrusion press which are not germane to the invention, are not shown, since general extrusion press construction is well known in the art. The particular parts of the press which are significant are shown, and include an extrusion die 10 which is mounted in a die holder 12, the latter being removably mounted in a die carrier 14. The die carrier and consequently the holder and die are movably mounted to engage the face of a billet container 16 which is secured in a container holder 18 forming part of the press. As is well known, the billet container usually comprises a hollow cylinder within which a plunger 20 is slidably movable, the plunger comprising the end of a ram 22 which is usually driven by hydraulic means to press the plunger 20 rightwardly as shown into the billet container and toward the die 10. If tubular extrusions are to be made, a mandrel 24 is secured to the face of the plunger 20, the mandrel entering the die aperture 26 of the die 10 and

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extruding a billet 28 placed in the die container between the mandrel 24 and the die aperture 26.

The die aperture 26 establishes the external dimensions and cross-sectional form of the extrusion, and the billet 28 is ordinarily forced into the aperture 26 along slopes or ramps 30 which form the entrance for the die 10. In the usual extrusion procedure, the interior of the die container and the inner face of the die 10 are generously coated with a suitable lubricant. Also, the billet 28 and the mandrel 24 are generously lubricated. The kind of lubricant depends upon the speed, temperature, and pressure involved in the extrusion. Frequently materials such as tallow, fortified with high melting point additives are utilized. When steel extrusions are accomplished at temperatures of the order of 2200° F. and at high pressure, the lubricant material becomes quite fluid and tends to leak through the die before much progress has been made in extruding the steel therethrough. Initial parts of the extrusion are adequately lubricated. However, if the lubricant, as is usual, is exhausted from within the billet container before the extrusion is complete, the last part of the extrusion pass is completed without benefit of lubrication which tends to increase the required pressure for extrusion, to wear the die unduly, and to deteriorate the surface finish of the extrusion. It would be desirable if possible to arrange for die lubrication throughout the entire extrusion pass to minimize die wear and to attain various other advantages.

According to my invention, I form the inner face of the extrusion die with a groove or pocket 32, demarked from the face of the die by a land 34. The pocket 32 and land 34 are annular in the arrangement shown, but need not necessarily be annular. The pocket 32 in conjunction with the end of the bore of the billet container, forms a cavity of considerable capacity which is filled with lubricant before a billet is loaded in the container 16 and before the extrusion pass begins. This lubricant is indicated at 36 in Fig. 3. The lubricant pocket 32 is connected with the upstream end of the die aperture 26 by a plurality of conduits 38 which are in the form of drillings, so that lubricant in the pocket can flow to the die aperture, thereby lubricating the aperture and the billet immediately upstream of the critical point at which the extrusion is given its final sizing and its final finish.

In the extrusion operation, the billet 28 is gradually necked down along the ramps 30 until the billet material passes through the aperture. Initial lubricant contained on the die face and on the billet assists the material of the billet in passing over the ramps 30 and through the die aperture 26 but this material as aforementioned, tends to exhaust itself before the extrusion is completed. The lubricant 36 in the pocket 32 on the die face provides a continuing supply to the critical portions adjacent the die aperture 26 throughout the extrusion pass whereby the extrusion is given good surface finish and whereby die wear is reduced.

In operation, when the extrusion pass starts, the billet is forced firmly against the land 34 on the die 10, sealing the lubricant in the pocket and allowing lubricant egress from the pocket only through the conduits 38. As the extrusion pass continues, pressure builds up in the billet container and the billet starts to flow through the die, substantially sealing off the downstream openings of the conduits 38 as the billet mandrel passes through the die. This is the easiest flow path for the billet so that its wedging into the pocket 32 around the die rim does not take place rapidly. However, as pressure continues to be applied, the billet material will gradually move into the pocket 32, forcing lubricant therefrom through the conduits 38 to ooze between the billet and the die immediately upstream of the aperture 26, thereby providing a

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continuing source of lubrication for the billet as it extrudes through the die.

While the precise mechanics of the extrusion phenomenon are not known in detail, it is assumed that the die operates to a certain extent as a venturi. There is likely, a pressure differential existing whereby the pressure of the billet adjacent the pocket 32 is relatively high and static, whereas the pressure in the necked down part of the die adjacent the aperture 26 is somewhat lower due to the higher velocity of billet material at this point. Thus, pressurized lubricant from the pocket passes through the conduits 38 to coat the billet immediately upstream of the aperture 26. Furthermore, there is very slow movement of the billet material adjacent the rim of the die and adjacent the bore surface of the billet container 16, whereas there is relatively high speed of motion between the billet material and the die in the small diameter portion thereof adjacent the aperture 26. This relatively high speed of motion enables the lubricant in the pocket to leach from the pocket to coat the billet material, under the influence of the static pressure on the lubricant in the pocket 32.

After the plunger 20 has moved almost to the extreme right of the billet container 16, the extrusion is substantially completed whereupon the plunger 20 is withdrawn and the remaining part of the billet is secured from retraction by a groove 42 formed adjacent the right hand end of the billet container. Thereafter, the die carrier 14 is disengaged from the billet container holder 18, and moved away from it. The extrusion is backed up through the die a short distance, and the residual part of the billet is cut off from the extruded product and is removed from between the die carrier 14 and the container 16. The extrusion is then drawn on through the die. Thereupon, the die carrier 14 can be restored to the position shown in Fig. 1, and the extrusion press is prepared for another extrusion pass by the appropriate application of lubricant as aforementioned, making the system ready for the insertion of a new billet and the pressing of a new extrusion.

The lubricant pocket 32 for containing lubricant 36 is shown in the present invention as being annular and adapted for a certain form and shape of die 10, and the conduits 38 are symmetrically arranged about the axis of the extrusion die which is shown as being adapted for the extrusion of circular tubes. For other extruded shapes and for different configurations of dies and presses, the pocket for the lubricant 36 and the conduits 38 may be arranged in other manner than that shown to secure effective results. The pocket 32 and conduits 38 are located to enable a suitable disposition of lubricant 36 between the die and the extrusion to make the operation as efficient as possible. The disposition of the features of

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the invention can best be established experimentally to yield optimum results in reducing die wear and in improving surface finish of the extrusion.

As shown at 38' in Fig. 3, the conduits may be disposed to deliver lubricant closer to the die aperture 26 than the conduits 38. The capacity of the pocket for the lubricant 36 may be made as large or small as required to contain sufficient lubricant, so that an adequate supply is assured throughout the entire extrusion pass. A principal requirement is that the pocket 32 be located where it is exposed to high substantially static pressure; for convenience it may be located in the die face as shown. It may be in the wall of the billet container, or in a separate compartment subject to the same or larger pressure than that to which the billet is exposed.

Though a single embodiment of the invention is shown, it is to be understood that the invention may be applied in various forms and in various environments. Changes may be made in the arrangements shown without departing from the spirit of the invention. Reference should be had to the appended claim for definition of the limits of the invention.

What is claimed is:

An extrusion apparatus including a container having a bore to receive a billet at one end for extrusion of the billet at the other end, a die in the said other end having an extrusion orifice, the walls of said orifice being of the cross-sectional shape of the extruded product desired and sloping on a curve inwardly of said bore and radially outwardly towards the wall of said bore and terminating in a planar face transversely of said bore, said planar face adjacent the walls of said bore being recessed to form an annular pocket for lubricant, said recess opening into said bore whereby lubricant contained therein will be subjected to the direct pressure of the metal being extruded, and conduits extending from said recess to said curved surface for conducting lubricant under pressure thereto.

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