This invention relates to extrusion dies as well as dies through which metal is drawn, and more particularly to such dies that are provided with inserts for better withstanding wear.

In the metal extrusion industry, continual effort is expended on material evaluation and designs for extrusion dies. This effort has increased in recent years, due to the need for longer die life in the interest of economy and for closer tolerances on extrusions. Requirements for high strength and high temperature alloys have resulted in extrusion temperatures and pressures above the useful range of conventional die materials. As a result, a number of operations the use of a single extrusion to a maximum of only a fraction of the number considered to be economically acceptable for production operations.

A considerable amount of work has been conducted in connection with spray coating die faces with a refractory material capable of withstanding the temperature-pressure conditions of extrusions more effectively. This approach has been used in the extrusion of refractory metal alloys at extremely high temperatures, by using a refractory oxide die coating such, for example, as Al₂O₃ or ZrO₂. Such coatings do prevent die wash, but the die still remains good for only one to four extrusions, which is uneconomical.

For extruding iron, nickel and copper base alloys, die inserts have been used to increase die life. For example, the insert may be made of an alloy of molybdenum and 0.50 titanium. The high melting point and high temperature hardness of this material far exceed conventional die steels, so that many more “in tolerance” extrusions per die can be expected. On the other hand, a disadvantage of this particular die design is the metallurgical condition of the insert material itself. Such a die insert may be machined from an upset forging, but its hardness level is considerably below that attained from a more highly worked material, because high hardness and strength are obtained in refractory metals by cold work hardening. In addition, the grain size and orientation of a machined insert are far from the optimum. A further problem with the usual die insert arises in connection with satisfactorily supporting or holding it in place.

It is among the objects of this invention to provide an extrusion or drawing die which has a considerably longer life under extreme conditions than those known heretofore, and the cost of which is not prohibitive.

In accordance with this invention, the die opening in a die block is lined, at least in the area where the most wear occurs, by a metal insert made from a formed metal plate or sheet. The forming can be done in various ways, such as by forging, spinning or stamping the blank.

The invention is illustrated in the accompanying drawings, which—

Fig. 1 is a view of the entrance face of a die;

Fig. 2 is a radial section therethrough;

Fig. 3 is a radial section through a modification; and

Fig. 4 is a perspective view of a sheet or plate that can be formed into the shape of an insert.

Referring to Figs. 1 and 2 of the drawings, a metal die block 1 of the desired shape is provided with a die opening 2 through it, which has the shape of the part that is to be extruded or drawn through the die. Viewed from the side, the opening has a tubular exit portion or land that is connected by a longitudinally curved intermediate portion to a flaring entrance portion (Fig. 2). The curved intermediate portion of the opening and at least part of the land are lined by a metal insert 3 of a different material having greater strength and better wearing qualities than the block.

In accordance with this invention, the insert is in the form of a deformed metal plate or sheet (hereinafter referred to as a sheet even though of plate thickness) produced by a metal working process, such as forging, spinning or stamping, as distinguished from machining or casting. That is, an originally flat metal sheet 4 of the desired shape of substantially uniform thickness, such as shown in Fig. 4, is formed into the same general shape as the portion of the die opening in which it is to fit. The forming can be done in any of the metal working ways just mentioned. Also, the sheet may be provided with a central hole before forming, or after the forming operation the smaller end of an unperforated insert may be cut off to provide the hole in the end of the passage through the insert.

In order to hold the insert 3 in place and provide support for it, it is preferred that the exit end of the die opening be reduced in size to provide the block with a shoulder 7 facing the entrance end of the opening. The insert abuts against the shoulder. The thickness of the shoulder is no greater than the thickness of the wall of the insert engaging it, so that a smooth passage is formed. Although the insert may cover or line the entire flaring entrance face of the die if desired, it generally is not necessary to provide the full entrance face, so the entrance end of the insert can terminate at a point above where the curved portion of the die opening merges into the flared portion. In such a case, the wall of the flared portion of the die opening is made flush with the inner surface of the adjoining part of the insert to form a smooth entrance into the restricted part of the die.

To further help hold the insert in place and prevent its entrance end from being dislodged by the metal being forced through the die, the insert may be locked in place in various ways. For example, the flaring wall of the die opening may be provided with a channel 8 extending into the die block. This channel extends around the opening and, in the case of a circular opening, is circular. The adjoining marginal portion of the insert is bent forward to provide a flange 9 that fits into the channel. The flange thus hooks the insert into the die block. The outer corner of the flange may be machined to form a sharp corner that will not leave a circular gap.

In the modification shown in Fig. 3, the die block is made from entrance and exit sections 11 and 12. The entrance section 12 includes only the flared portion of the die opening 13. The entrance section of the block may be provided with a radial shoulder 14 engaged by the exit end of the insert 15 formed from a metal sheet as before and lining the more critical part of the opening. To help hold the insert in place, it is provided at its entrance end with an outwardly projecting radial flange that fits in a gap 16 between the two die block sections. The two sections can be clamped against this flange in any suitable manner. The portion of the die opening that is exposed to the most abuse is lined by the insert. The flared portion of the die opening merges into the passage through the insert. When the insert requires replacement, the two sections of the die block are separated and the whole insert replaced by a new one, which then is clamped between the die sections.
The inserts described herein are worked into shape and thus have improved metallurgical characteristics. Thus, the material of our insert formed from an alloy of molybdenum and 0.50 percent of titanium has a hardness of 320 D.P.H. and a yield strength of 85,000 p.s.i. for the same alloy forming an insert made from an upset billet. Our inserts are easily held in position and readily replaced. The stock weight of material required for manufacturing the inserts is greatly reduced as compared with known practices, and there is little waste. Therefore, use of high cost materials can be considered.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. An extrusion die and the like, comprising a metal block provided with a die opening therethrough provided with an entrance face and a land, and a metal insert lining at least the portion of said opening that is subjected to the greatest wear, said insert having an entrance face and a land and being a formed metal sheet having a central passage therethrough.

2. An extrusion die and the like, comprising a metal block provided with a die opening therethrough having a tubular land connected to a flaring entrance portion by a longitudinally curved intermediate portion, and a formed metal sheet having a central passage therethrough of the same general shape as said opening, said sheet being inserted in said opening and lining said intermediate portion and at least part of said land.

3. An extrusion die and the like, comprising a metal block provided with a die opening therethrough provided with an entrance face and a land, the wall of said entrance face being provided with a channel extending around said opening and toward the exit face of the die, said channel having concentric side walls and a metal insert lining at least part of said land, the insert being a formed metal sheet having a central passage therethrough and provided at its entrance end with a marginal flange projecting into said channel between its side walls to hold the insert in place.

4. An extrusion die and the like, comprising a metal block provided with a die opening therethrough having a tubular land connected to a flaring entrance portion by a longitudinally curved intermediate portion, the block being formed from entrance and exit sections spaced apart to form a gap between them, the entrance section containing said entrance portion of the die opening, and a metal insert lining said intermediate portion and at least part of said land, the insert being a bent metal sheet having a central passage therethrough and provided at its entrance end with a radially projecting portion disposed in said gap in engagement with said block sections to hold the insert in place.

5. An insert for lining an extrusion die and the like, the insert having an entrance face and a land and being a formed metal sheet having a central passage therethrough.

6. An insert for lining an extrusion die and the like, the insert having an entrance face and a land and being a formed metal sheet having a central passage therethrough, the outer edge of said entrance face being provided with a surrounding anchoring flange.

7. An insert for lining an extrusion die and the like, the insert having a tubular land connected to a flaring entrance portion by a longitudinally curved intermediate portion, the insert being a formed metal sheet provided at its entrance end with a surrounding anchoring flange extending toward the opposite end of the insert.

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