

Sept. 8, 1970

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3,527,079

FEEDER HOLE DIE WITH IMPROVED METAL FLOW

Filed Aug. 1, 1966

5 Sheets-Sheet 1

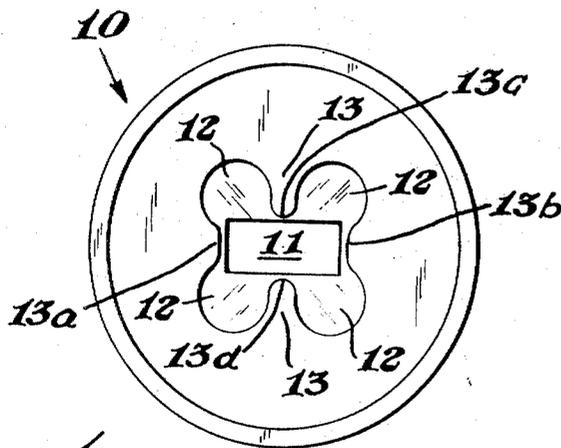


Fig. 1

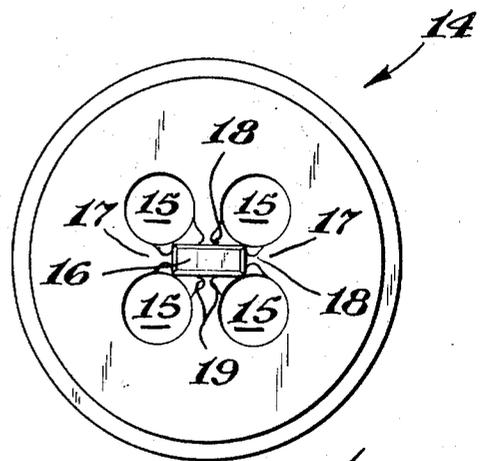


Fig. 2

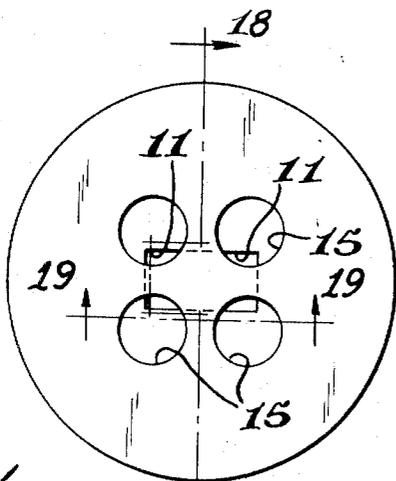


Fig. 3

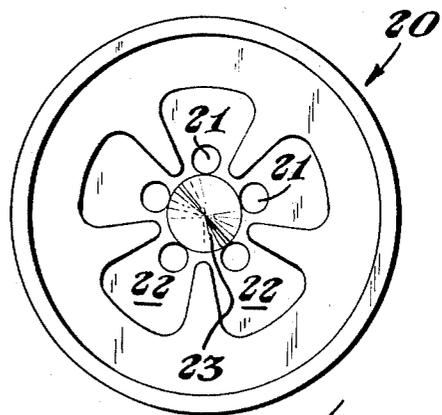


Fig. 4

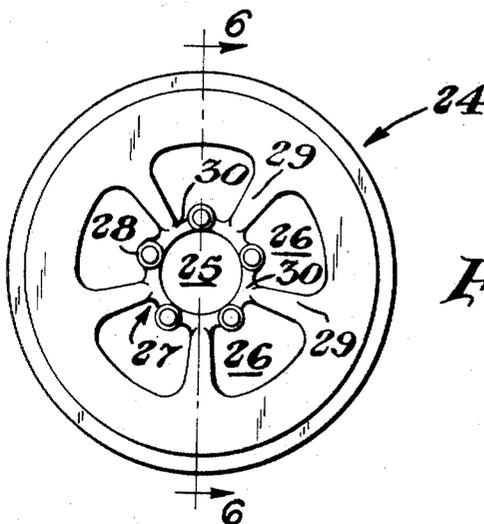


Fig. 5

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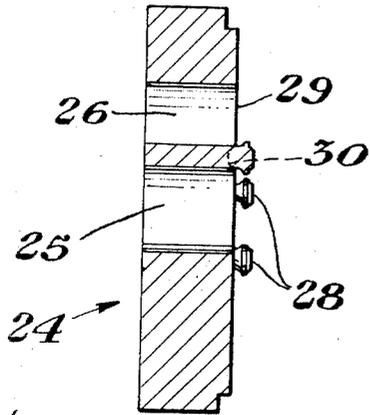


Fig. 6

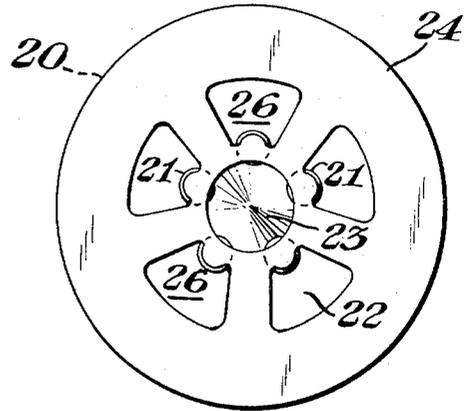


Fig. 7

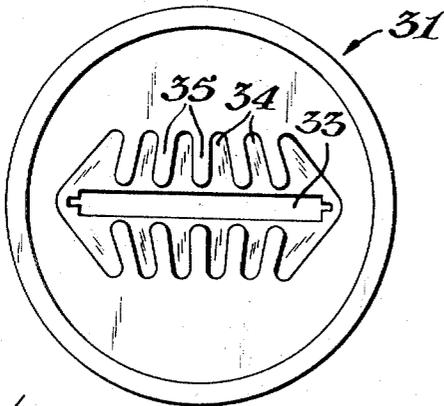


Fig. 8

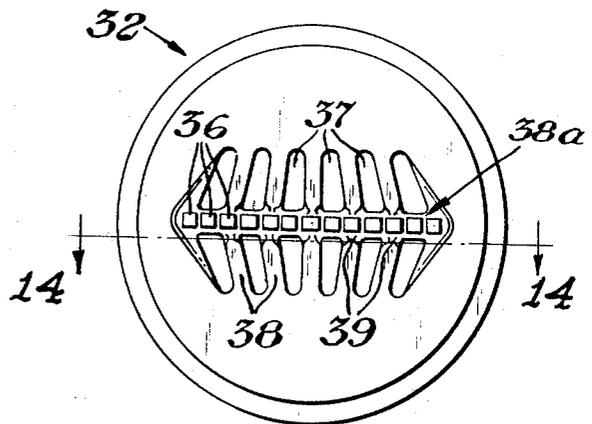


Fig. 9

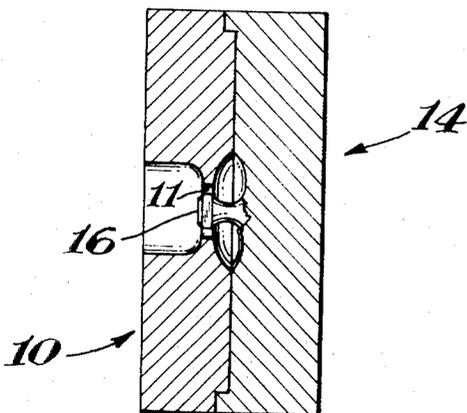


Fig. 10

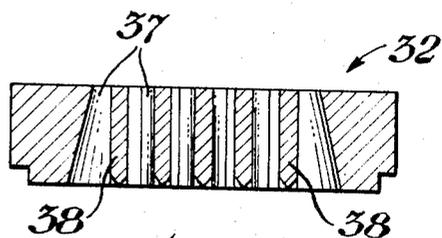


Fig. 14

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5 Sheets-Sheet 3

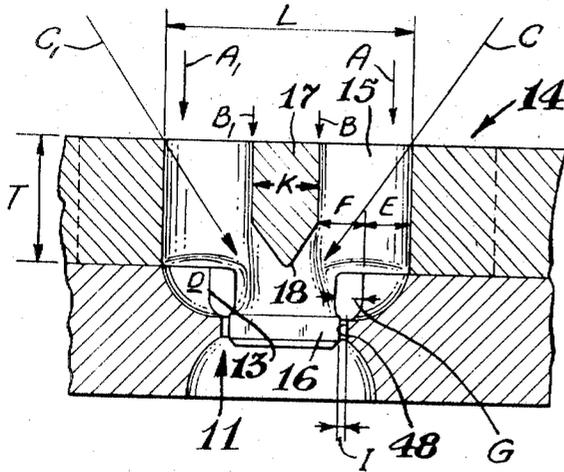


Fig. 19

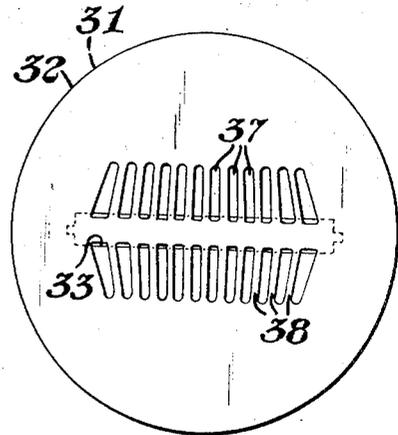


Fig. 15

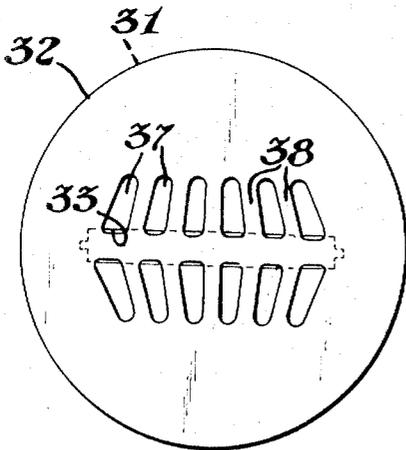


Fig. 10

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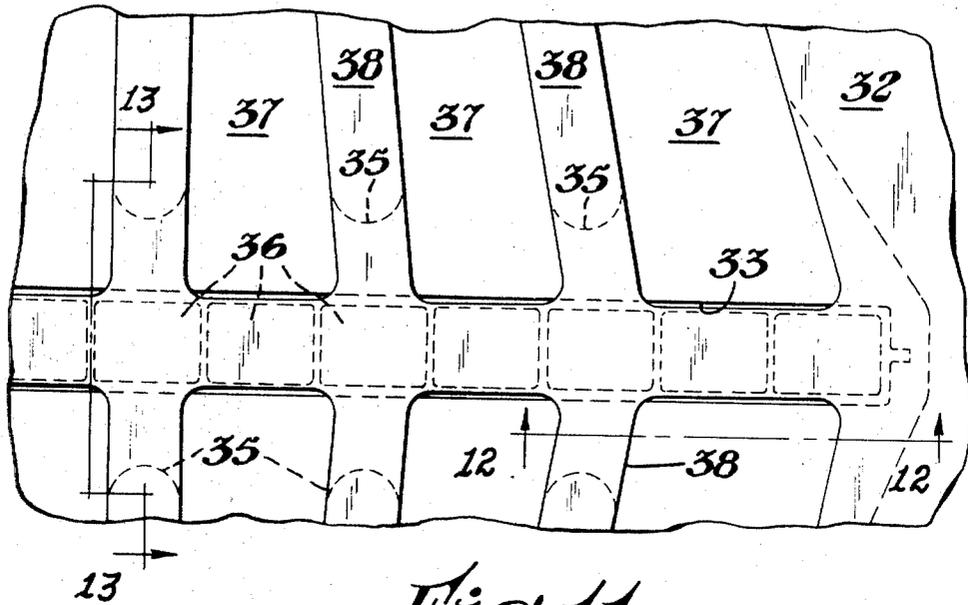


Fig. 11

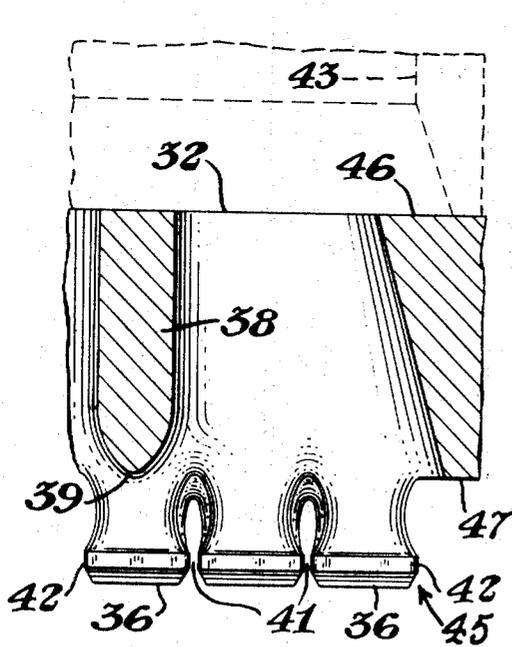


Fig. 12

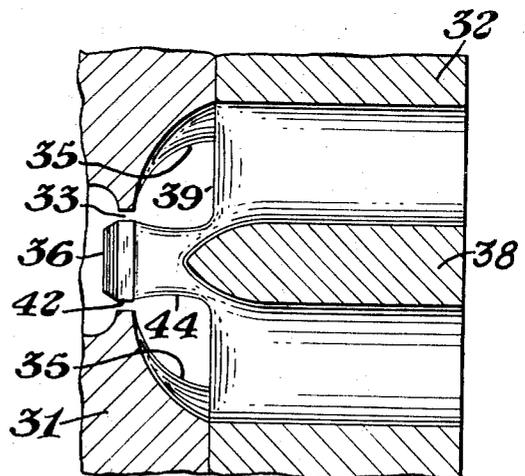


Fig. 13

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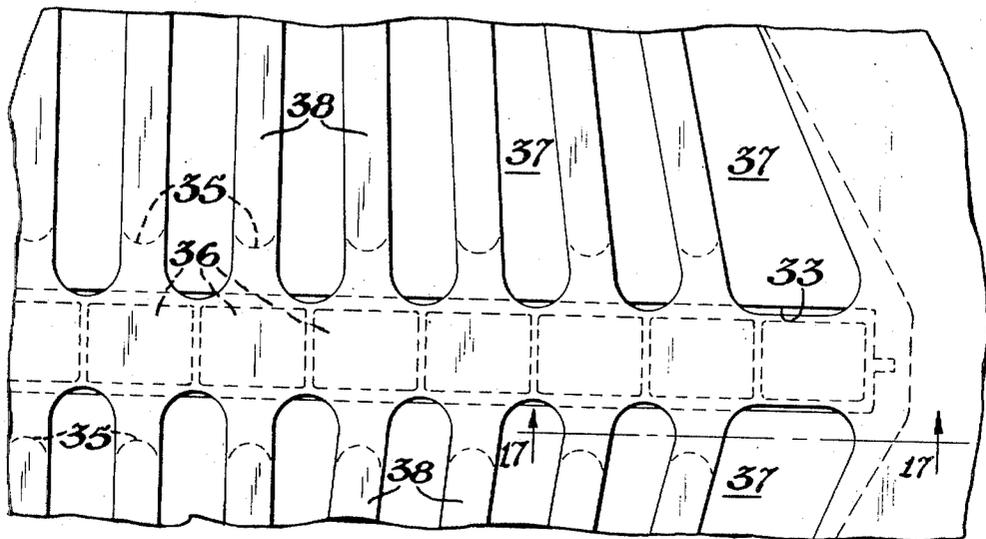


Fig. 16

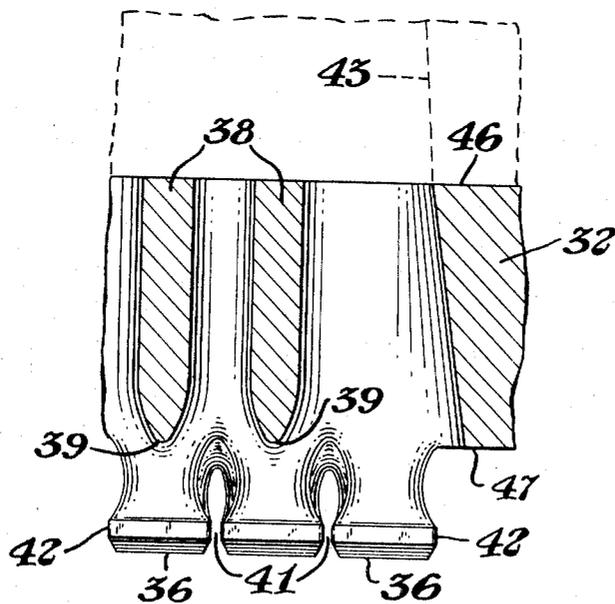


Fig. 17

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**FEEDER HOLE DIE WITH IMPROVED  
METAL FLOW**

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U.S. Cl. 72-269

9 Claims

**ABSTRACT OF THE DISCLOSURE**

A feeder hole die having feeder holes in the feeder hole plate in substantial alignment with the die orifice or orifices of the die plate, the feeder holes being large enough and of proper configuration whereby at least 50% of each die orifice is visible through the feeder holes, collectively, which serve the orifice, when viewed along the axis of each feeder hole, respectively, and from the billet side of the feeder hole plate, and at least 90% of the orifice being visible when viewed through the feeder holes from the billet side of the feeder hole plate and, furthermore, scanned from all possible line of sight positions, permits substantial improvements in metal flow and better flushing out of residual metal remaining in the die from the previous push. The die is further improved upon tapering the bridges at the die plate side, in flaring the feeder holes whereby at least 50% of the die orifice is contiguous to the openings in the feeder holes, in providing dish-shaped saucer-shaped depressions in the die plate adjacent to the die orifice, in providing supporting integrally formed pads in the die plate to support the bridges of the feeder hole plate to reduce support span to a minimum and thereby to reduce the distance between the innermost boundary of each pad to the adjacent bearing land of the die to not more than about two times the wall thickness of the shape produced by the porthole die adjacent to such pad, and the span being not greater than one inch, in placing each mandrel symmetrically on the bridge structure and further in employing a relatively thin feeder hole plate.

The die of the invention permits substantial increases in volume of material moved through the die while minimizing die wear.

The invention relates to an improved die for the extrusion of hollow shapes including multi-hole hollow shapes.

Metal tubing formed of light metal is commonly extruded around a mandrel and through a female die member. Multi-hole shapes are similarly extruded except that a plurality of mandrels and die orifices must be employed. A typical single-cavity extrusion takes the shape of a rectangular or a circular cross-section tube. A typical multi-hole extrusion from such a die assembly is a hollow panel for vehicle floors. Such a panel has opposed planar surfaces, each perhaps 0.2 inch thick, supported and spaced about 2 inches apart by a series of webbing member portions, each having about the same thickness as the planar surfaces. A typical panel might be 24 inches wide with about 13 webbing member portions so that the panel has in effect 12 holes running the full length thereof. Each hole is formed around a mandrel and during the extrusion operation, the entire substantially rectangular die opening has 12 mandrels positioned therein in a substantially straight line array.

Porthole dies have been used for many years for extruding hollow shapes. The art of making porthole dies is generally well developed for making single-hole hollow shapes. However, a multi-hole shape such as the panel described above presents new problems. When prior art

methods for designing porthole dies were applied to multi-mandrel dies, defective extrusions were produced. One of the main defects encountered has been the formation of weak weld zones in the extrusion as a result of metal flowing together around the bridges between portholes and then flowing together into a shape having a continuous section. In addition, further difficulties have been encountered in cracking and breaking or distorting of mandrels and mandrel support structures. Another difficulty encountered has been excessive wear of the die orifice.

It is therefore a principal object of the present invention to provide an improved design for porthole dies for the extrusion of hollow shapes in which better metal flow through the die assembly is achieved.

It is an additional object of the invention to provide an improved porthole die having stronger bridge structure between the portholes.

Another object of the invention is to provide for the use of a thinner feeder hole plate.

Another object of the invention is to provide an improved porthole die through which hollow shapes are extruded with substantially improved welding together of metal streams flowing around the bridge structure.

Another object of the invention is to provide a porthole die in which less metal is retained at the end of the push.

These and other objects and advantages of the present invention will be more apparent to those skilled in the art upon becoming familiar with the following description and the appended drawings in which like reference numerals refer to like parts, and:

FIG. 1 is a front elevation of a die plate for making a hollow rectangular tube. The plate is viewed from the feeder hole plate side;

FIG. 2 is a front elevation of the feeder hole plate used with the die plate of FIG. 1 and viewed here from the die plate side;

FIG. 3 is a view of the plates of FIGS. 1 and 2 aligned and juxtaposed showing the feeder hole openings in full and the die orifice in dotted outline;

FIG. 4 is a front elevation of a die plate for making a plurality of cylindrical tubes simultaneously, the plate being viewed from the feeder hole side;

FIG. 5 is a front elevation of the feeder hole plate employed with the die plate of FIG. 4 and viewed from the die plate side;

FIG. 6 is a sectional view taken along line 6-6 of FIG. 5 showing the taper in the bridges adjacent the mandrels and feeder hole openings on the die plate side;

FIG. 7 is a view of the plates of FIGS. 4 and 5 aligned and juxtaposed and showing the extent of feeder hole and die orifice alignment. The feeder hole openings are shown in full, while the individual die orifices are shown in dotted outline;

FIG. 8 is a view in front elevation showing a die plate for making a multi-hole hollow shape, the plate being viewed from the feeder hole side;

FIG. 9 is a view in front elevation of the feeder hole plate employed with the die plate of FIG. 8, the feeder hole plate being viewed from the die plate side;

FIG. 10 is a view of the plates of FIGS. 8 and 9 aligned and juxtaposed and showing feeder hole and orifice alignment, there being but one feeder hole per pair of intersections of webbing member with the planar surfaces of the multi-hole shape formed on extruding metal through the die;

FIG. 11 is an enlarged, fragmentary view of the same billet side of the assembly shown in FIG. 10, showing the feeder holes in full, the die orifice and pads of the die plate, as well as the mandrels of the feeder hole plate, being shown in dotted outline;

FIG. 12 is a fragmentary view of a section taken along line 12-12 of FIG. 11 showing the taper in the bridges

between the portholes and the flare in the feeder hole around the end of the array of mandrels;

FIG. 13 is a fragmentary view of a section taken along line 13—13 of FIG. 11 showing more detail of bridge taper, the supporting pad, and the beveled-out portion of the die plate adjacent the pad;

FIG. 14 is a view in section taken along line 14—14 of the view shown in FIG. 9;

FIG. 15 is a view similar to that of FIG. 10 showing a feeder hole plate and a die plate aligned and juxtaposed and showing feeder hole and orifice alignment for an assembly for making the same extruded shape as made with FIG. 10, there being one feeder hole for each intersection of webbing member portions with the planar surfaces of the multi-hole shape formed on extruding metal through the die;

FIG. 16 is a view similar to FIG. 11 showing an enlarged fragmentary view of the assembly of FIG. 15;

FIG. 17 is a fragmentary view in section, taken along line 17—17 of FIG. 16;

FIG. 18 is a view in section along line 18—18 of the assembly of FIG. 3; and

FIG. 19 is a fragmentary view of a section taken along line 19—19 of FIG. 3.

The invention is based on the discovery that upon providing feeder holes in the feeder hole plate in substantial alignment with the die orifice or orifices of the die plate, the feeder holes being large enough and of proper configuration whereby at least 50 percent of each die orifice is visible through the feeder holes, collectively, which serve the orifice, when viewed along the axis of each feeder hole, respectively, and from the billet side of the feeder hole plate, and at least 90 percent of the orifice being visible when viewed through the feeder holes from the billet side of the feeder hole plate and, furthermore, scanned from all possible line-of-sight positions, substantial improvements in metal flow, and especially a better flushing-out of the residual metal remaining in the die from the previous push, which if not readily flushed out by the next following billet is frequently the cause of long laps and inferior welds, both of which are undesirable requirements of pressure capacity of the press, bridge strength requirements, and better die wear as well as improved seams are each achieved. The die of the invention is further improved upon tapering the bridges at the die plate side, in flaring or slanting holes whereby at least 50 percent of the die orifice is contiguous to the openings in the feeder holes, in providing dished-out, saucer-shaped depressions in the die plate adjacent to the die orifice, in providing supporting pads in the die plate to sufficiently support the bridges of the feeder hole plate and reduce the unsupported bridge span between pads and bridges to a minimum whereby the distance between the innermost boundary of each pad to the adjacent bearing land of the die is not more than about 2 times the wall thickness of the shape producible by the die orifice at this point, but not to exceed 1 inch in placing each mandrel symmetrically on the bridge structure between adjacent feeder holes, and, further, in employing a thinner feeder hole plate whereby its thickness is established complementary with the width of all bridges (such width having been established by design to satisfy the abovesaid requirements of feeder holes being contiguous with the die orifice), whereby those shear stresses are satisfied which result from an assumed load (i.e., metal pressure at the die) on the bridge and feeder hole plate and mandrel portions projecting into the feeder hole area, equivalent to the total area of the section as if it were solid, plus the area of the bridges at the billet side to the extent they extend outside the section or shape area and are not supported by supporting pads.

If the thus-established thickness of the feeder hole plate is equal to or larger than the total or major span from pad to pad, bending stresses can be disregarded. If the major span is larger than the thickness of the feeder hole

plate, bending stresses must be calculated, and combined shear and bending stresses must both be taken into consideration in calculating a proper thickness for the feeder hole plate.

One of the main objectives of this invention is to arrive at a die design in which all the active and passive elements of die design militating against each other are minimized, maximized, or optimized in the direction of a much improved and effective design, resulting in better extrudability, lower pressure requirements, better welds, better yields of usable material, better die life, and savings in die steel since most feeder hole plates of the invention are thinner, when applying these design principles.

The use of slanted feeder holes, especially if directed from the center of the die towards the outside will also prevent, in many cases, the undesirable effect of billet skin feed-in. The outer skin of the billet, especially when unscalped, will prematurely participate in the metal flow, e.g., before reaching the normal butt length, and will travel into either the peripheral elements of the shape or even into the weld and thus result in defective extrusions. Such slanted feeder holes will also allow the extrusion of hollow shapes whose largest dimension may exceed the container diameter.

Having a multitude of feeder holes feeding only the immediate vicinity of the section and being contiguous to the feeder hole results also in a much more uniform flow and, therefore, results in much less local or overall distortion of flatness of the section, especially very wide sections.

Metals which may be extruded using the improved die of the invention include especially magnesium and aluminum and the alloys of each respectively having one of these metals present in the proportion of 70 percent or more by weight and being of a composition containing no constituents which prevent welding of the metal in the die.

The die assembly of the invention is preferably constructed of a high strength steel, especially a tool steel, having substantial tensile yield strength and compression yield strength at extrusion temperatures on the order of 800° F. As a specific example, a tool steel containing about 5 percent of chromium and having the A.I.S.I.-S.A.E. designation of H-11 or H-12 is suitable to use in the construction of the present die.

The improved dies of the invention will be better understood with reference to the various dies illustrated in the drawings. The die plate 10 shown in FIG. 1 consists of a circular steel disc having a rectangular orifice 11 formed through the center of the disc. Surrounding the orifice and substantially equally spaced are four saucer-like depressions 12 with flat floors which serve to feed metal from the feeder hole plate along an inclined plane inwardly from the surrounding plate surface and into the die orifice 11. The face of the die plate is also tapered towards the orifice 11 from the intervening ridges or pads 13 between the saucer-like depressions 12 to the edge of the orifice. These ridges are generally referred to as pads since they support the bridges between feeder holes during use of the die.

The feeder hole plate 14 is shown in FIG. 2 as viewed from the die plate side and is a plate which is complementary to the die plate of FIG. 1. The two plates taken together comprise a die assembly. Four feeder holes 15 are formed through the plate about a centrally-disposed mandrel 16. The mandrel 16 projects from the face of the die plate and is adapted to fit into the die orifice 11 of the die plate 10 shown in FIG. 1 so as to provide an assembly suitable for extruding a single hollow tube of rectangular cross-section. The feeder hole plate 14 is further characterized by tapering of the bridges 17 between the feeder holes, the bridges each having a short portion adjacent the mandrel which tapers to a narrow, rounded ridge 18 at the face directed toward the die plate and in

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the vicinity of the point where each bridge joins the mandrel 16 and serves as a support therefor. The smooth, rounded, concave surfaces 19 on either side of each ridge 18 provide for even flow of the metal out of the feeder holes 15, in part through the gap between the ridges 13 and the orifice of the die plate 10 around the mandrel 16 and through the die orifice 11.

In FIG. 3 there is shown the die plate and the feeder hole plate of FIGS. 1 and 2 in juxtaposed aligned relationship whereby the billet side of the feeder hole plate is visible. Looking through each of the feeder holes 15, serially and respectively along a line normal to the feeder hole plate and from the billet side, a very substantial part, i.e., at least 50 percent in total, of the perimeter of the die orifice 11 is visible, the visible parts being shown in full and the remainder of the perimeter being shown in dotted outline. The mandrel 16 has been omitted from this view for the sake of simplicity.

The relationship of the mandrel 16 of FIG. 2 to the die orifice 11 of FIG. 1 is more clearly illustrated in FIG. 18. In FIG. 18 is shown a sectional view taken along line 18—18 of the assembly of FIG. 3, showing the relationship of the die plate and the complementary feeder hole plate of FIG. 2. The mandrel 16, as shown, projects slightly into the die orifice 11 and is supported by the feeder hole plate so as to be centrally disposed within the die opening. The tapering or depressions in parts of the facing surfaces of the two plates adjacent the mandrel 16 and the die orifice 11 respectively is readily apparent.

The parts of die assembly representing another embodiment of the present invention are shown in front elevation in FIGS. 4 and 5. The die plate 20, shown in FIG. 4, has the form of a steel disc having 5 die orifices formed there-through and centrally disposed in a circular evenly spaced array. A dished-out depression 22 is provided around each orifice 21, the greater part extending radially outward from the orifice. The floor of each depression 22 is substantially flat and the plane of the floor is inclined inwardly from the plate surface to the adjacent orifice 21. The central feature of the die plate is a conical projection or boss 23 which serves further to guide the metal smoothly into the respective die orifices 21.

The die plate side of the feeder hole plate 24 is shown in FIG. 5. The feeder hole plate 24 has the form of a circular steel disc having a central circular feeder hole 25 surrounded by five individual feeder holes 26 each separated from the central feeder hole 25 by a ring bridge 27. On the ring bridge 27 are supported five mandrels 28 each aligned with one of the individual feeder holes and projecting from the feeder hole plate 24 so as to extend into a die orifice 21 in the composite assembly. The bridges 29 between the individual feeder holes 26 are narrowed, with respect to the width between the feeder holes, to a ridge 30 adjacent each mandrel 28, the narrowest portion being at the face of the plate shown. Each bridge 29 extends radially outward from the central feeder hole 25. The relationships of the tapering surfaces, the individual feeder holes, the mandrels and the central feeder hole are further illustrated by the sectional view taken along line 6—6 of FIG. 5 and shown in FIG. 6.

The view of the composite die assembly in FIG. 7 is similar to the view shown in FIG. 3 and illustrates the extent to which the perimeters of the die orifices are visible on looking through the feeder holes 26, 26 in the feeder hole plate 24 along a line normal to the face of the feeder hole plate and in alignment with each feeder hole respectively. As in FIG. 3, the feeder hole plate is viewed from the billet side, and the mandrels have been omitted for the sake of simplicity. The portions of die orifices which are visible are shown in full and the remaining portions are shown in dotted outline.

Yet another embodiment of the present invention is shown in the die plate 31 of FIG. 8 and the complementary feeder hole plate 32 of FIG. 9. The die plate 31 is formed of a circular steel disc having a rectangular die

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orifice 33 with end extensions or slits formed there-through substantially along a diameter thereof. The die assembly represented by the plates of FIG. 8 and FIG. 9 provides for the extrusion of a multi-hole, hollow panel with side flanges usable, as for example, as flooring for a wheeled vehicle. The panel consists of opposed planar surfaces that are joined together and supported by a series of cross-members more familiarly referred to as webbing members. The die orifice 33 as shown is surrounded by a series of dished-out depressions 34 which are each adapted to direct metal from the feeder hole plate along an inclined plane-like floor and into the die orifice 33. The individual depressions are located so as to receive metal from individual respective feeder holes. Each of the saucer-like depressions 34 is separated from adjacent saucer-like depressions by pads 35 which terminate adjacent the die orifice 33.

The complementary feeder hole plate 32, as shown in FIG. 9, is provided with a series of mandrels 36 in close-spaced, linear array. The group of mandrels is designed to extend into the die orifice 33 when the two plates are placed together in operative relationship.

In using the plates together in an extrusion operation, the surfaces of the said panel are formed between the perimeter of the die orifice and the collective perimeter of the entire array of mandrels, while the webbing members of the extruded panel are integrally formed between the individual mandrels 36. The mandrels 36 are integrally formed with the feeder hole plate 32 and supported thereby. In addition, the mandrels are surrounded by an array of individual feeder holes 37. Each of the feeder holes 37 extends through the feeder hole plate 32 and are defined, in part, by intervening bridges 38 between the feeder holes located on a common side of the array of mandrels, and, in part, by the elongated bridge structure 38a on which each mandrel is formed. Each bridge 38 throughout a very short portion 39 immediately adjacent the bridge structure 38a is narrowed towards the die plate side. The length of the very short portion 39 substantially coincides with the length of the gaps between the pads 35 and the die orifice 33 in the complementary die plate 31. In any event in the dies of the invention, the mandrel or mandrels are always formed with an extremely short shank which joins the feeder hole plate closely adjacent to the trailing edges of the bridges and inherently close to the die plate and the die orifice in the composite die assembly.

The view of the composite die assembly in FIG. 10 is similar to the views shown in FIG. 3 and in FIG. 7 and illustrates the extent to which the perimeters of the die orifices are visible on looking through the feeder holes of the particular feeder hole plate of FIG. 9 along a line normal to the face of the feeder hole plate and in alignment with each feeder hole respectively. The feeder hole plate is viewed in front elevation from the billet side and the mandrels have been omitted for the sake of simplicity of illustration. The portions of die orifices which are visible are shown in full and the remaining portions are shown in dotted outline. The orifices illustrated are those of the complementary die plate shown in FIG. 8.

In FIG. 11 is shown an enlarged and fragmentary view in front elevation of the assembly of FIG. 10. Only the feeder holes 37 of about one-half of the plate 32, and only those at one side of the array of mandrels 36 are shown for the sake of clear illustration. The mandrels 36 and also the pads 35 and the die orifice 33 of the die plate are presented in dotted outline in order to show the relationship of the feeder hole to the die orifice with which there is substantial alignment. The superposition of the bridge 38 with the pads 35 is also illustrated.

As seen in the fragmentary sectional view in FIG. 12, taken along line 12—12 of FIG. 11, the end feeder hole flares outwardly to feed the end of the die orifice and the first two intersections of the shape. These intersections consist of the junctions of webbing members with planar surfaces, the webbing members being formed by the

spaces 41 between the mandrels 36, the webbing members receiving final form on passing over mandrel bearing lands 42. In the view in FIG. 12, the die plate has been omitted in order to show the mandrels 36 more clearly.

Also notable in FIG. 12 is the configuration of the feeder hole plate 32 with respect to the adjacent container wall 43, here shown in dotted outline, to illustrate one way in which billet skins may be kept from readily flowing preferentially into the stream of extruding metal.

The slant of the bridges 38 towards the end 45 of the array of mandrels, from the billet side 46 to the die plate side 47 of the feeder hole plate 32, further aids in preventing billet skins from entering the main stream of extruding metal, though the bridges may be made without slant if not desired, or if not needed, as when the billets are scalped before extrusion.

The relationship of each of the pads 35 of the die plate 31 to the bridges 38 of the feeder hole plate 32, and the relative tapering of surfaces of the mandrel support structure for the mandrels 36, are all shown in FIG. 13 taken in section along line 13—13 of FIG. 11. The narrowing of the pad 35 coincides with the narrowing of the bridge 38, the narrowest portion 39 of the bridge 38 being in the gap between the inward end of the pad 35 and the die orifice 33. This gap represents the unsupported span of the bridge 38. The tapered portions 44 of the mandrel 36, provide for flow of metal between adjacent mandrels for the formation of webbing members in the extruded shape.

The relative narrowing of the bridges 38 at the die plate side of the feeder hole plate 32 is further illustrated in the sectional view of FIG. 14.

The composite die assembly illustrated in FIG. 15 is similar to the assembly shown in FIG. 10 except that the number of feeder holes is increased so as to provide one feeder hole, on each side of the row of mandrels, for each webbing member formed on extrusion. Thus, there is one feeder hole for each intersection of webbing members with a planar surface. As in FIG. 10 the feeder hole plate is viewed from the billet side and the mandrels have been omitted for the sake of simplicity. The portions of die orifices which are visible through the feeder holes are shown in full and the remaining portions are shown in dotted outline.

The fragmentary portion of FIG. 15 shown in FIG. 16 illustrates the detail of the arrangement of one feeder hole per intersection of the shape to be formed. FIGS. 16 and 17 are like FIGS. 11 and 12, except for the different feeder hole to intersection ratios and the omission of slanting feeder holes for the handling of billet skins, the feeder holes in FIG. 17 extending substantially normal to the plate surfaces.

The relationships of bridge or plate thickness, bridge span, and die plate support to the strength of the die metal are better understood with reference to the view in section in FIG. 18 and the related fragmentary view in section in FIG. 19, both being sections of the assembly of FIG. 3.

A relatively thin feeder hole plate 14 is highly desirable to use to reduce friction, and thus necessary pressure capacity of the press, and such thinner plate can be used if the thickness  $T$  of the plate 14 is established complementary with the width  $K$  of all bridges 17,  $K$  having been established by design to satisfy the requirements of feeder holes 15 being substantially contiguous with the die orifice 11, whereby shear stresses resulting from an assumed load (metal pressure at die) on the bridge and feeder plate and mandrel portions projecting into the feeder hole area equivalent to the total area of the section (as if it were solid) plus the area (billet side) of the bridges exceeding the section area and not supported by supporting pads 13. If the thus-established thickness  $T$  is equal to or larger than the total unsupported span  $L$  of the bridges 17, bending stresses can be disregarded. If thickness  $T$  is smaller than total unsupported span  $L$ , bend-

ing stresses must be calculated, and combined shear and bending stresses must be the basis for the calculation of the thickness  $T$ .

More specifically, the pads 13 must sufficiently support the bridges 17 and reduce to a minimum the free span, indicated by the letter  $F$ , which extends between the innermost boundary or apex of pad 13 marked  $E$  and the nearest point on the bridge 17, whereby distance  $G$  between the innermost boundary of pad 13 to line normal to the shank of the adjacent mandrel is not more than about two times the wall thickness  $I$  of the shape extrudable from the assembly at this point.

The limits of bridge thickness are also better understood with reference to FIG. 19, wherein the means of determining the extent of visibility of the die orifice are illustrated. On viewing the orifice through each feeder hole 15 along a centrally-disposed line such as  $A$  and  $A_1$ , at least about 50 percent of the orifice must be visible, summing up the portion viewed through each feeder hole 15, in turn serially and collectively. Further, upon scanning the orifice from the billet side of the feeder hole plate, and from all possible lines of sight, including lines  $B$  and  $B_1$ , directed along the edges of the bridges, and lines  $C$  and  $C_1$ , which are diagonally directed across the feeder holes.

As may be seen from the foregoing discussion and examination of the figures shown in the drawings, the present improved feeder hole die is characterized by considerably more straight line flow of the metal from the feeder holes to the die orifice, by the bridges between the feeder holes having edges tapered in the direction of metal flow, by the feeder holes being flared on the die plate side so as to deliver even more metal directly into the die orifice, by the die plate on the feeder hole side being provided with dished-out areas aligned with respective feeder holes so as to feed the metal along a smooth curve and into the die orifice, by the use of a thinner feeder hole plate, by the mandrel(s) employed being symmetrically located on a bridge or bridges between feeder holes. The present die design is especially applicable wherein the number of feeder holes in the feeder hole plate exceeds four, and even more, wherein the number of feeder holes exceeds about seven. As a consequence of these improvements in die design, there is obtained better metal flow through the composite assembly, less waste of metal remaining in the die assembly at the end of a push, less visible seams obtained as a result of metal flowing around the bridges in the feeder hole plate than the seams obtained using prior feeder hole dies. Thinner bridges between feeder holes are made possible, yet they are less subject to damage and the feeder hole plate itself may be thinner and, as a consequence, less pressure is wasted by frictional forces.

Among the advantages of the present invention is the extremely low incidence of distortion, either immediate or delayed, of extrusions obtained using the present die.

The improved feeder hole die of the invention having been thus fully described, various modifications thereof will at once be apparent to those skilled in the art and the scope of the invention is to be considered limited only by the breadth of the claims hereafter appended.

I claim:

1. A porthole die for extruding magnesium and aluminum and the alloys thereof containing at least 70 percent by weight of one of these metals comprising a feeder hole plate and a complementary die plate;
  - a) said die plate having at least one die orifice formed therethrough;
  - b) said feeder hole plate having a plurality of feeder holes formed therethrough and bridges remaining between the feeder holes, at least one mandrel integrally formed therewith such bridges and supported thereby, said bridges extending substantially from face to face of the feeder hole plate and said at least one mandrel extending substantially into said at least one die orifice when the die plate and feeder hole plate

are assembled together in juxtaposed operative relation and said at least one mandrel being formed in the feeder hole plate closely adjacent the trailing edges of said bridges;

the feeder hole in the feeder hole plate being substantially aligned with the at least one die orifice whereby at least 50 percent of the die orifice is visible, in total through the feeder holes when viewed serially and respectively, along a line normal to the face of the feeder hole plate surrounding each feeder hole; and the bridges each resting on pads between depressions in the die plate adjacent the die orifice, and none of the said bridges having an unsupported span, between the innermost boundary of such pad to the shank of the adjacent mandrel, greater than about two times the wall thickness of the shape producible by the adjacent die orifice and mandrel.

2. The die as in claim 1 in which the total proportion of die orifice visible in total through each feeder hole taken serially and collectively, and the orifice being scanned from all possible line of sight positions for each feeder hole, being at least 90 percent.

3. The die as in claim 1 in which the total number of feeder holes is greater than four.

4. The die as in claim 1 in which the total number of feeder holes is greater than seven.

5. The die as in claim 1 in which the maximum thickness of bridges between adjacent feeder holes as measured on the billet side is in the range of about one-fourth to about one-half of the diameter of the feeder holes.

6. The die as in claim 1 in which the die plate has a side facing the feeder hole plate, and said side has a generally saucer-shaped depression formed therein in alignment with each said feeder hole, each said depression being adapted to lead metal being extruded along a smooth curve and into an immediately contiguous die orifice.

7. The die as in claim 1 in which a plurality of spaced-apart mandrels are employed in a linear array and are disposed in a single orifice in the die plate;

a feeder hole being provided for each spacing between adjacent mandrels and being adapted and positioned to feed metal into each said spacing.

8. The die substantially as in claim 7 in which one feeder hole is provided for substantially each adjacent pair of spacings between mandrels and each such feeder hole is substantially aligned with said pair of spacings and adapted to feed metal thereinto.

9. The porthole die, as in claim 1, wherein:

the feeder hole plate has the form of a circular steel disc having a central circular feeder hole surrounded by an array of substantially equal-sized, equal-spaced individual feeder holes, each spaced from the central feeder hole by a ring bridge, said ring bridge supporting an array of equal-sized mandrels, each aligned with one of the individual feeder holes;

and the die plate has the form of a circular steel disc having a circular array of die orifices equal in number to the number of mandrels and spaced apart so as to receive the complementary mandrels when the feeder hole plate and the die plate are juxtaposed in operative relation.

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