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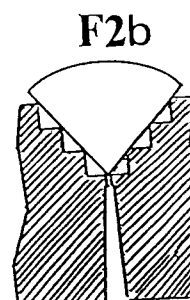
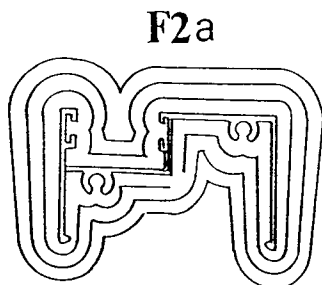
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(54) **Calculating system for constructing dies for extruding solid aluminum shapes.**

(57) **CALCULATING SYSTEM FOR CONSTRUCTING DIES FOR EXTRUDING SOLID ALUMINUM SHAPES**
which eliminates the use of varying heights of cuts by utilizing an alignment chart to calculate the metal's angle of entry into the die, said angle being formed between the axis of the die and the width of the feeder slot cut into the die.



This invention is a calculating system for constructing dies for extruding solid aluminum shapes.

Traditionally, solid aluminum shape extruding dies with one or more deliveries are built using cut heights which differ according to the thickness of the shape and its distance to the center, in order to regulate the flow of metal and obtain the correct form and measurements.

5 Feeding antechambers have also been used to ensure a good union or weld between two consecutive extrusions.

We have developed a system for calculating the metal feed into dies for extruding one or more solid aluminum shapes which makes the use of varying cut heights unnecessary.

10 Our system consists fundamentally in using alignment charts or mathematical formulas to determine the metal entry angle that must be formed between the shape's axis and the width of the feeder slot or antechamber cut into the front of the die for each cross-section of the shape, depending on its thickness and distance to the center.

15 Since the flow of metal is regulated by the width of this angle at each point, the feeder antechambers may be cut into one or more steps, such that the edges of each step restrict the opening of the feeder angle at each point, or, with the correct means of mechanization, the inner walls of the chamber may even be cut into the previously calculated angle.

When the thickness of metal in the shape is to be greater, a smaller angle is calculated; and when its thickness should be lesser, a larger angle is calculated.

20 These conditions mean that the correct quantity of metal reaches each point of the cross-section of the shape, and cuts are not required as feed regulators. Therefore they may be omitted or, if they are included for ease in construction, they will have all points of the form or shape to be extruded at the same height, which may range from 0.5 to 20 millimeters.

25 In order to find this metal feeder angle, we have experimentally evaluated the feed produced at each point of the die with regard to the die's center, at variable metal entry angles and varying with a parameter which we shall call μ , which measures the relationship between surface area and perimeter for each cross-section of the shape. To do so, the perimeter of the orifice is divided by the orifice's surface area.

30 These data were obtained experimentally. An alignment chart (see Figure 1) was devised illustrating the relationship between said data, and the mathematical expressions defining the curves were calculated. With these tools and the rules for using them, we put together a computer program based on a commercial drawing system which allows us to project the die and obtain its CAD description on diskette, which may then be incorporated into the CAM of the die-building machines.

For a better understanding of this report, the enclosed drawings are attached to illustrate one nonrestrictive example of execution of the invention, in which:

35 Figure 1 gives the coordinates of the alignment chart used to project the die, in which:

d = distance to the center of the die (measured in millimeters)

L = feed (measured in percentages)

A = chamber width (measured in millimeters)

P = chamber depth (measured in millimeters)

α = chamber angle (measured in degrees)

40 Figure 2a is a plan view of one of the symmetrical figures comprising a metal shape die.

Figure 2b is a section showing the contours of the steps in the feeder chamber as well as the measurements that determine the feeder angle.

Figure 3a is a plan view of one of the four symmetrical deliveries of a shape.

Figure 4 is a plan view of the antechamber and the location of the deliveries in the experimental process.

45 Figure 5 is a section of the metal entry angle.

Figure 6 is a plan view of the extruding chamber for one type of shape.

Figure 7 is a cross-section of the same chamber.

50 In order to calculate the feeder chambers for dies with just one cut, a series of tests was run aimed at quantifying the variables intervening in the design and correction of dies with a feeder antechamber and a single cut. In this first part, we consider only solid dies, and we shall attempt to reflect the sequence of our tests.

We had a 2000 M.T. extrusion press with a 200 mm. $\varnothing$ container, and a small wax extrusion press with a 300 mm. long tank having a $\varnothing$ of 200 mm.

We tested different wax compositions with a normal die until we obtained a creep similar to that of aluminum, comparing the behavior of the ends of the shapes in both extrusions.

55 For one die, we mechanized twelve 6 mm. $\varnothing$ deliveries with 3 mm. of cut in three concentric circles, arrayed into 4 perpendicular radii.

The first series of deliveries, without an antechamber, was used as our control sample.

In the second series, with the same cut length and rod diameter, we placed a 20 mm. $\varnothing$, 10 mm. deep

antechamber at the entry.

The separation between antechambers was great enough to avoid interference in wax flows.

In the third series of deliveries, with the same antechamber diameter, we increased the depth to 15 mm., maintaining the same diameter and cut height.

In the fourth series of deliveries, maintaining the same depth of 15 mm. for the antechamber, we increased the diameter to 26 mm.

After a series of tests and a comparison of their results, we reached the conclusion that in each concentric circle from the center of the die, the feed and therefore the extruded length varied with the metal entry angle (α) formed between the delivery diameter and the chamber diameter.

We then repeated the tests with aluminum. By measuring the run length flowing out of each delivery, we reached the following conclusions:

- For the same entry angle, the extruded length decreases the further the deliveries are from the center of the die.
- For similar entry angles, there is a similarity between the lengths extruded from orifices located the same distance from the center of the die.
- At a constant diameter, as the depth of the chamber increases, metal creep decreases.
- The maximum feed is obtained when there is no antechamber, which in theory is equal to an entry angle (α) of 180°.

In view of these conclusions, we decided to quantify the results, and the possible variables and test alternatives for doing so are as follows:

TEST NUMBER	1	2	3	4
Distance to die center	Variable	F.	F.	F.
Metal entry angle	Fixed	V.	F.	F.
Shape thickness	Fixed	F.	V.	F.
Delivery cut height	Fixed	F.	F.	V.

After running tests 1, 2 and 3 and quantifying the parameters, we used the results to construct a graph for calculating die sizes, shown in Figure 1.

Said calculation is performed as follows:

With the sketch of the die we wish to project in view at all times, we start with a circle having 85% of the diameter of the container we will use for extrusion, and we distribute the number of deliveries we wish, arranging them so that the centers of gravity of the figure coincide with the centers of gravity of the parts of the circular sector they occupy.

Next we start at the center and draw concentric circles at every 16 mm. of radius. These circles will cross the figures of the shapes at different points.

We will number these points of intersection from the inside out, and we will draw up a table giving the values of:

Point No. Circle Value of μ Feed Antechamber Depth Width

Next, using the graph, we follow the values of μ for each point, and at their intersection with the curve of the circle in which this part of the figure lies, we have the forecast feed in ordinates at the right. Continuing horizontally until we intersect with the straight lines numbered c_1, c_2, c_3, c_4, c_5 , etc., the projection of the intersection will give us in abscissas the feed angle in the antechamber. From here, choosing an antechamber depth of 5, 10 or 15 mm., we will obtain the width of the antechamber at this point of the figure.

After completing the table, we will sketch circles of the calculated diameter at each point chosen.

Next, by joining the circles with straight tangent lines, we will obtain a sketch of the contours of the antechamber.

Should the geometry of the figure make it impossible to build antechambers with the calculated widths because they interfere, we have two solutions:

- In the first, if the values of μ are very close for various points, we choose the maximum diameter we can sketch in the critical parts of the figure without two continuous lines interfering, and we follow the graph backwards in order to calculate the maximum feed this antechamber will allow. Next we reconstruct the rest of the antechambers, based on this maximum feed, tracing along straight lines c_1, c_2, c_3, c_4, c_5 , etc., to obtain the necessary angle. With this we will obtain a die whose feed will be lower but

balanced.

- A second possibility, for dies having variable values of μ , consists in stacking feeder chambers with different heights, so that, even when the circles of the large chamber interfere, at a lesser depth there will appear other chambers, with a smaller diameter and shallower depth.

Heretofore we have tested dies with a maximum cut of 2 mm. and, in some cases, cut-free dies, sharpening the bearing at an accelerated angle of 3° , obtaining useable dies which in all cases yield extrusion rates of up to 80 meters per minute.

Examples of use.

Example No. 1.

Figure 2a is a plan view of one of the two symmetrical figures forming a die for a shape to be used in window construction. The feeder angles calculated with the aid of the alignment chart are marked over the drawing of the three steps that have been cut to form the feeder angle. Throughout the entire figure, the cut height is 2 mm.

The form of the steps in the feeder chamber and the measurements that determine the feeder angle, as it varies for each point in the die, appear detailed in cross-section form in figure 2b.

This die was cut into an H-13 steel disk and, after tempering and grinding, said die was used to manufacture shapes, yielding a shape of the correct measurements and forms inside tolerances, at an extrusion rate of 60 meters per minute.

Example No. 2.

Figure 3a gives a plan view of one of the four symmetrical deliveries of a shape to be used for vertical curtain tracks.

As in the previous case, the plan view illustrates the three steps that, as they contour the shape, define the feeder angle of the antechamber which will supply aluminum to each point of the shape in the necessary quantities in order to regulate delivery and obtain the correct forms and measurements.

The cut height contouring the form of the shape is 1.5 mm. throughout the figure.

The feeder angles were calculated with the aid of the alignment chart in Figure No. 1.

The cross-section of the antechamber steps limiting the feeder angle calculated for each point of the die is drawn in figure 2b.

This four-delivery die was made of H-13 steel, tempered and ground, and used for extrusion in a 1600 M.T. horizontal aluminum press, producing from the very start excellent quality aluminum shapes with correct measurement tolerances and surface finish at a rate of 65 meters per minute.

Lastly, after the above description, it remains only to indicate that this invention may admit as many variations in execution as possible without altering its essence as described above, and may be manufactured in all manner of forms, sizes and materials whatsoever.

NOTE: Having sufficiently described the above, it remains only to indicate that what the applicant declares personal and new is what is contained in the following:

Claims

1. Calculating system for constructing dies for extruding solid aluminum shapes, wherein there are one or more deliveries in which the flow of metal forming each part of the shape or shapes is regulated by means of a metal entry angle at each point of the shape, which angle shall be calculated in reciprocal ratio with the thickness desired for said shape such that the cut forming the form of the figure, if there is such a cut, shall have the same length throughout the figure of the shape.
2. Calculating system for constructing dies for extruding solid aluminum shapes as set forth in claim 1 above, wherein the form of the feeder chamber and the depth thereof are determined by said metal entry or feeder angle and may consist of one or more steps, for ease in mechanization, and the inner edges of said steps are what, along with the axis of the shape at each point, determine the entry angle, and in extreme cases the entry angle may even be cut whole, without intermediate steps.
3. Calculating system for constructing dies for extruding solid aluminum shapes as set forth in claim 1 above,

wherein the cut heights forming the form of the shape are the same at all points of the die, since in our system they do not influence the regulation of the metal flow and may vary from a ground surface to 20 or more millimeters, whereas dies are normally manufactured with cuts of 0.5, 1 or 2 mm.

5 All the above as described in this report comprised of twelve numbered pages typewritten on one side only and attached drawings.

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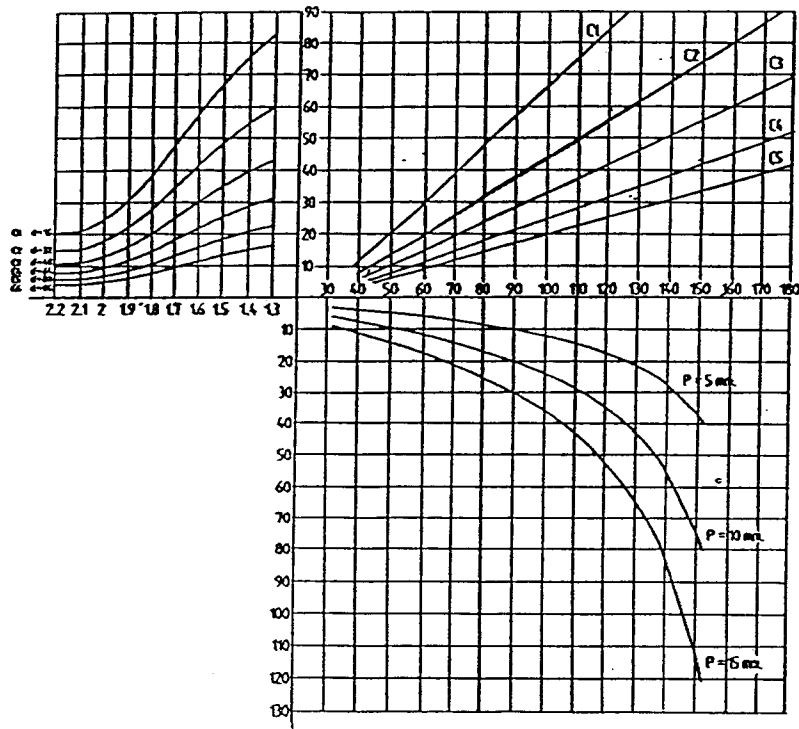
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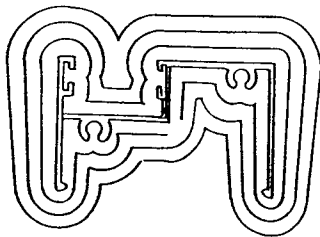
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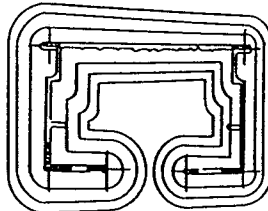
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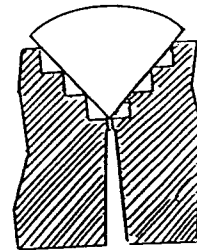
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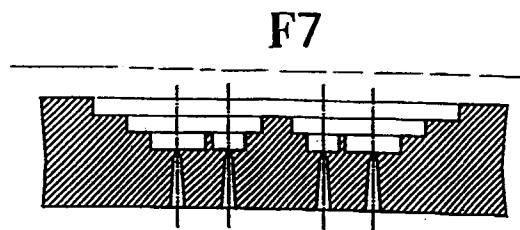
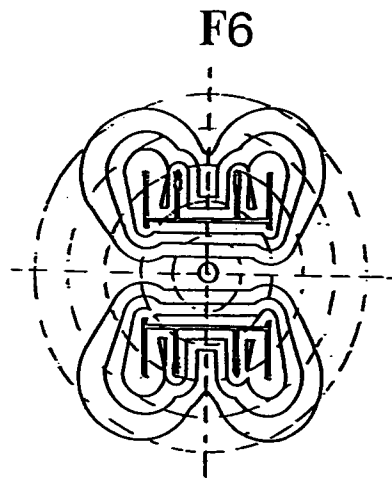
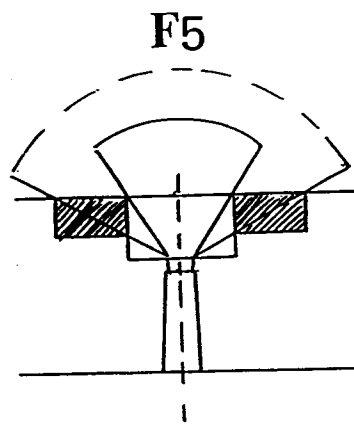
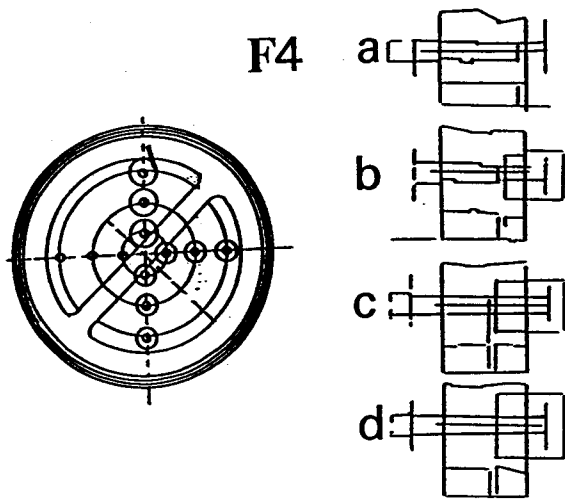


F3a



F2b







European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 93 50 0052

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 359 (M-1289)4 August 1992 & JP-A-41 11 918 (TOYAMA KEIKINZOKU KOUGIYOU KK) 13 April 1992 * abstract *	1-3	B21C25/02
A	US-A-2 750 034 (GERSMAN) * column 9, line 13 - line 52; figure 8 *	1,2	
A	DE-A-3 414 994 (JOSEF GARTNER & CO) * page 6, line 33 - page 7, line 4; figures *	1-3	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B21C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 30 AUGUST 1993	Examiner BARROW J.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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