March 11, 1969 W. L. LIPSCOMB 3,431,601

MODULAR DIE

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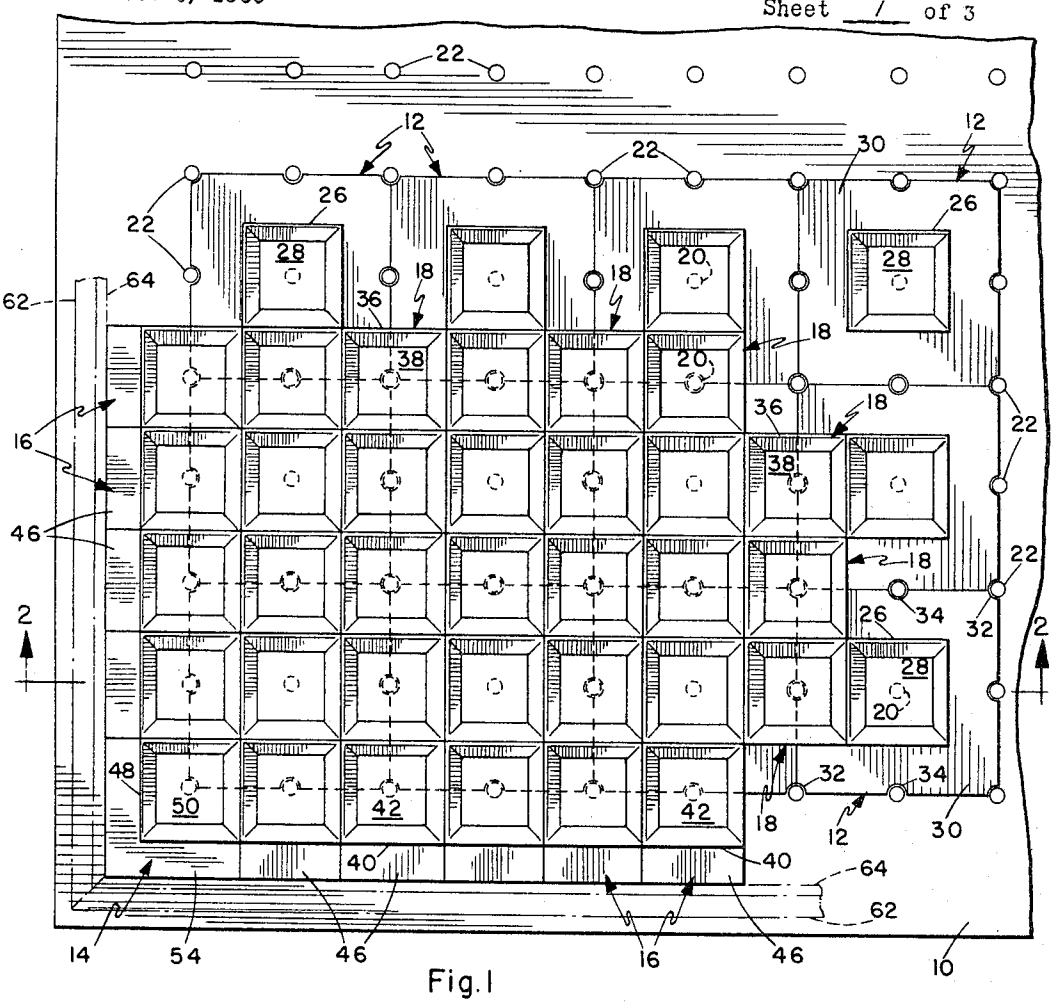

Fig. 1

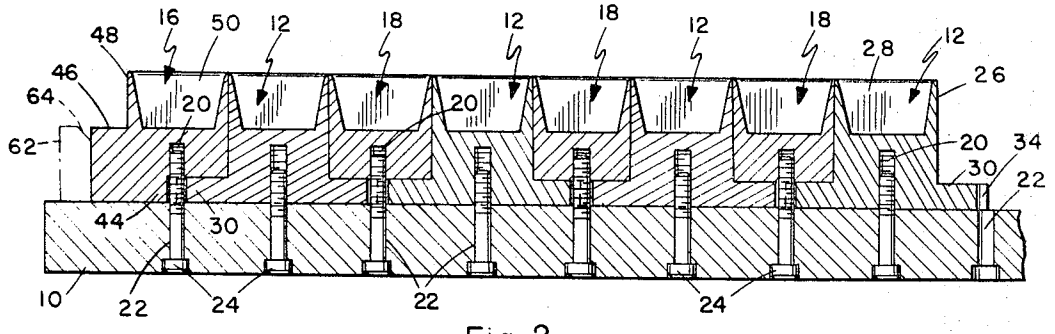

Fig. 2

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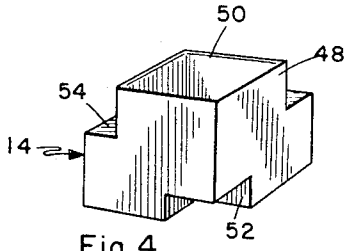

Fig. 4

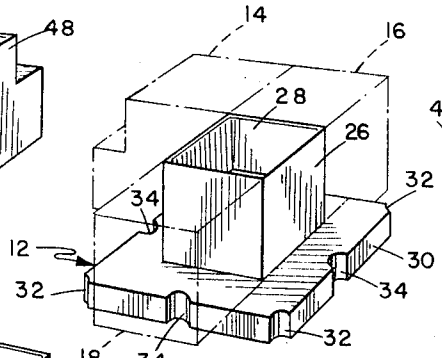

Fig. 3

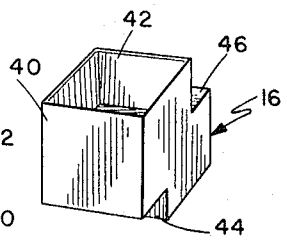

Fig. 5

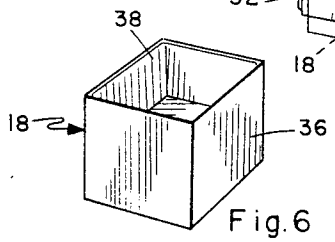

Fig. 6

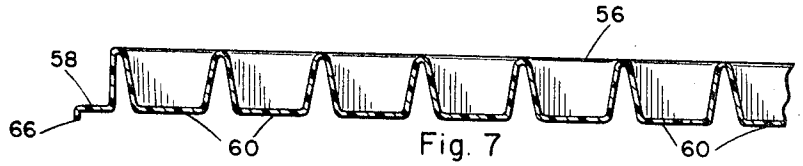

Fig. 7

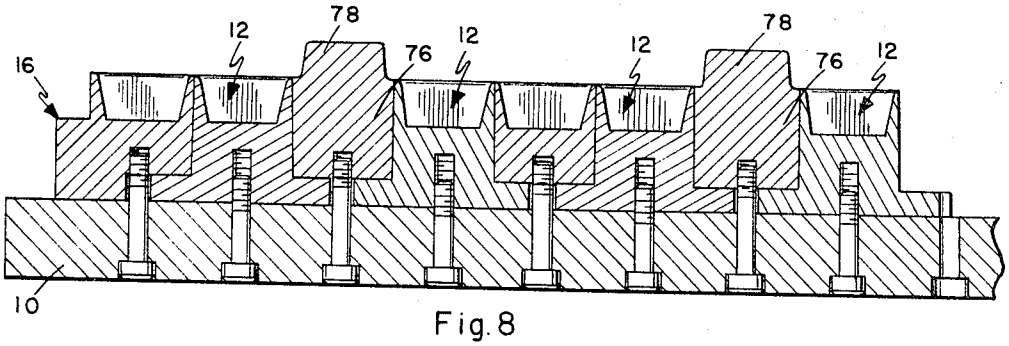

Fig. 8

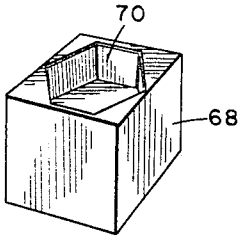

Fig. 9

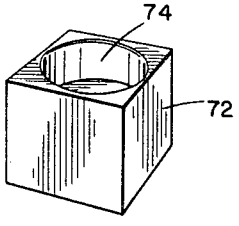

Fig. 10

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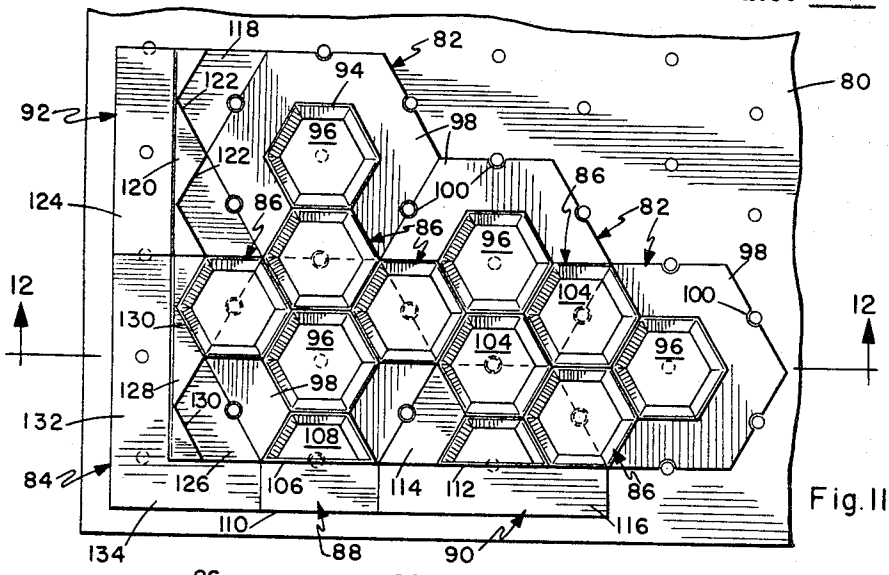

Fig. 11

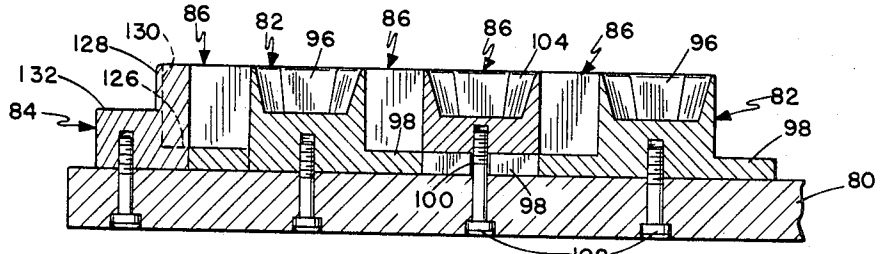

Fig. 12

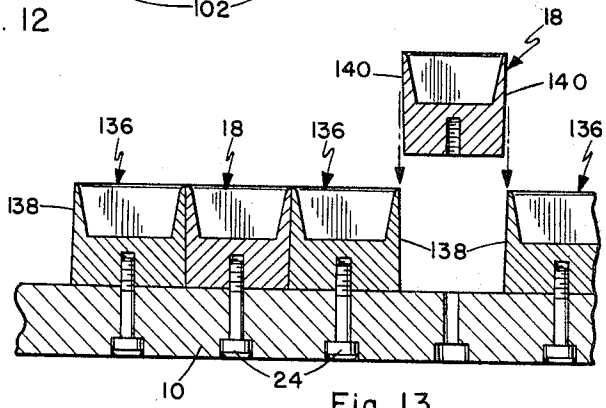

Fig. 13

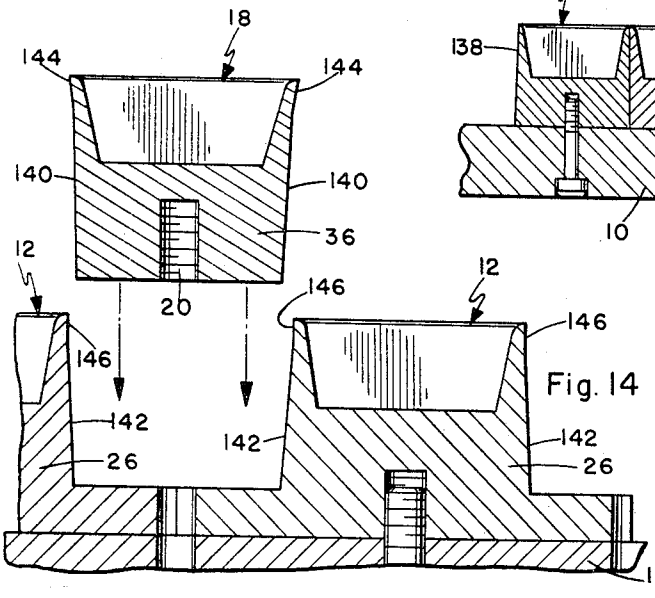

Fig. 14

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Patented Mar. 11, 1969

3,431,601

MODULAR DIE

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Filed Dec. 5, 1966, Ser. No. 599,138
U.S. Cl. 18—44 7 Claims
Int. Cl. B29c 1/06

ABSTRACT OF THE DISCLOSURE

The modular die utilizes a plurality of shaped die elements of a minimum number of different types which can be interfitted in a specific pattern to build up a forming or molding die of any required overall size in which the elements can be arranged to provide the formed article with a uniform, repetitive or even random pattern.

Background of the invention

The present invention relates to manufacturing techniques and specifically to a modular die adaptable to vacuum or pressure forming of plastics, injection molding, casting of plastics or metals, or other techniques in which material is formed over shaped elements.

Among the articles which are most suitable for forming with the modular die are light control louvers or panels of cellular construction, decorative panels, screens and the like, which have an overall pattern of raised or indented zones, either uniformly repetitive or somewhat randomly arranged. Such panels are normally made on large dies made in a single piece or in large sections of the particular pattern. Large dies are expensive to make and if a portion is damaged the entire die, or at least a large portion of the die, must be replaced. In addition, a large unitary die is impractical for a small number of panels due to cost.

Summary of the invention

The modular die described herein is composed of individual shaped elements each conforming to a single feature, such as a cell, of a composite pattern. The elements are designed to interfit in a variety of arrangements on a rigid bed plate and are self-aligning in assembly. Only a few different types of elements are required to build up a large die, with finished edges and corners and a distinctive pattern over all or parts of the die. If a portion of the die is damaged or is required to be changed, individual elements may be removed and replaced without disturbing the remainder of the die.

Brief description of the drawings

The basic die structure and various types of die elements are illustrated in the drawings, in which:

FIGURE 1 is a top plan view of a portion of a die, partly assembled;

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1;

FIGURE 3 is a perspective view of a base die element;

FIGURE 4 is a perspective view of a corner die element;

FIGURE 5 is a perspective view of an edge die element;

FIGURE 6 is a perspective view of an insert die element;

FIGURE 7 is a sectional view of a portion of a panel formed on the die assembly of FIGURE 2;

FIGURE 8 is a sectional view similar to FIGURE 2, but with alternative insert elements at certain positions;

FIGURE 9 is a perspective view of an alternative insert element;

FIGURE 10 is a perspective view of a further alternative insert element;

FIGURE 11 is a top plan view of a hexagonal type die partially assembled;

FIGURE 12 is a sectional view taken on line 12—12 of FIGURE 11;

FIGURE 13 is a sectional view showing an alternative interfitting arrangement of die elements; and

FIGURE 14 is an enlarged sectional view, similar to a portion of FIGURE 2, showing the configuration of the elements to ensure close fitting and eliminate gaps.

Similar characters of reference indicate similar or identical elements and portions throughout the specification and throughout the views of the drawings.

Description of the preferred embodiments

The die is assembled on a rigid bed plate **10** which forms the base and support for the complete die. In the simple configuration shown in FIGURES 1–6 the die is assembled to form a cellular panel with square cells in a uniform pattern. Four different types of die elements are all that are necessary to make up the die and these include a base element **12**, a corner element **14**, and edge element **16** and an insert element **18**, shown in FIGURES 3, 4, 5 and 6, respectively. To facilitate accurate assembly all of the die elements have certain common dimensions which, in this instance are the dimensions of the square cells in the pattern. In the underside of each die element is a threaded socket **20**, preferably at the geometric center of the common dimensioned portion for uniformity. Bed plate **10** has pre-drilled holes **22** spaced to correspond with the common dimensions of the die elements, that is, to align with threaded sockets **20** when the die elements are assembled in interfitting configuration, so that each element is held by a single screw **24**. This uniformity allows the die elements to be assembled in a variety of different arrangements with complete accuracy of alignment and continuity of the pattern. However, other means of attachment may be used if necessary for special die arrangements.

Base element **12** has an upright box portion **26** of square configuration with a depressed cavity **28** conforming to a cell of the panel to be formed, and at the lower end of the box portion is a laterally extended, symmetrically circumferential base flange **30** also of square shape. Base flange **30** extends from each side of box portion **26** a distance equal to half the width of the box portion, so that when two base elements **12** are secured with their base flanges abutting, the space between the confronting sides of the box portions will be equal to the width of a box portion. The corners of base flange **30** have arcuate notches **34** and the center of each side of the flange has an arcuate notch **36**, to provide clearance for screws **24** in the assembly.

Insert element **18** has a box portion **36** similar in size to box portion **26** and with a corresponding cavity **38**, but no flange.

Edge element **16** has a box portion **40** with a cavity **42**, also corresponding to box portion **26**, but below one half of box portion **40** is a dropped base portion **44** equal in thickness to flange **30**. Base portion **44** extends from one side of box portion **40** and is integral with a shoulder **46** along that side, the upper face of the shoulder being substantially coplanar with the bottom of cavity **42**.

Corner element **14** is somewhat similar to edge element **16**, having a corresponding box portion **48** and cavity **50**, but the dropped base portion **52** and shoulder **54** extend around two adjacent sides forming the outer corner.

It should be noted that all of the box portions are of equal vertical height, so that the upper edges are in a

common plane when assembled and correspond to the basic plane of the panel to be formed.

In assembly, the base elements **12** are secured in place first with their flanges **30** abutting, as in FIGURE 1, and provide a basic framework on which the remainder of the elements are assembled. This simplifies alignment and layout of any particular patterns which may be used. It will be seen that notches **32** and **34** combine to form clearance holes for screws in alignment with the bed plate holes **22**. Corner elements **14** are then added at the corners of the assembly, the overall size of which is determined by the number of base elements used. The box portions **48** rest on the flanges **30** of the corner base elements when the dropped base portions **52** are pulled down by screws **24** to seat on bed plate **10**. Next the edge elements **16** are added and also rest on base flanges **30** along the outer edges of the assembly. All intervening spaces are then filled with insert elements **18**, each held by its own screw **24**, to complete the cellular pattern. The relative positioning of the elements around a base element **12** is indicated in broken line in FIGURE 3. The shoulders **46** and **54** form a continuous shoulder surrounding the assembly which, in the formed panel **56** shown in FIGURE 7, provides an edge flange **58** coplanar with the bottoms of cells **60**. If an accurate trimming guide is required a trim bar **62** may be fitted around the periphery of the die, as indicated in broken line in FIGURES 1 and 2. Trim bar **62** has a bevelled edge **64** adjacent the shoulders **46** and **54** to form a shallow groove, into which the panel material is forced to provide a trim flange **66**. This also prevents undue stretching of the panel material around the edges of the die.

The cellular cavities are by no means limited to the square form, even with the square configuration of the elements. In FIGURE 9, for example, an insert element **68** is shown with a hexagonal cavity **70**, while FIGURE 10 shows an insert element **72** with a cylindrical cavity **74**. Either of these is interchangeable with insert elements **18** to provide variations in the pattern. Many different shapes can be incorporated into any or all of the die elements to form panels of various configurations. It is not necessary for all of the cells to be on one side of the basic plane of the panel. In FIGURE 8, for example, are shown insert elements **76** having raised portions **78**, which would form cells on the opposite side of the panel from those formed in the adjacent cavities. Raised portions of various configurations can be incorporated into die elements other than the insert elements if required.

The die elements can have a basic planform shape other than square, as in FIGURES 11 and 12, in which the pattern is hexagonal. In this configuration, assembled on a bed plate **80**, the die elements include a base element **82**, a corner element **84**, an insert element **86** and three types of edge elements **88**, **90** and **92**, which are necessary to complete the hexagonal pattern. Base element **82** has a hexagonal box portion **94** with a correspondingly shaped cavity **96** and a peripheral base flange **98**, also hexagonal. At the center of each edge of base flange **98** is a semicircular notch **100** to provide clearance for retaining screws **102**, which hold each element in place.

Insert element **86** is a simple hexagonal box containing a cavity **104** and corresponds to insert element **18**. Edge element **88** has a half-hexagon box portion **106** with a corresponding cavity **108** and fits over the base flange **98** in the manner of edge element **16**, an external shoulder **110** providing the edge flange of a formed panel.

Edge element **90** has a box portion **112** similar to portion **106**, but includes a half-hexagon base flange **114** to fit between the base flanges of adjacent base elements **82**. The outer edge of element **90** has a shoulder **116** to match shoulder **110**.

Edge element **92** has a V-shaped base flange **118** to fit around a portion of base flange **98**, and an upright wall **120** having a pair of V-shaped recesses **122** to receive portions of insert elements **86**. Along the outside of wall **120** and co-extensive therewith is a shoulder **124**.

Corner element **84** is similar in many respects to edge element **92**, having a base flange **126**, wall portion **128** with recesses **130** and a shoulder **132**, differing only in having a shoulder **134** continuing around one end.

As with the square configuration the hexagonal elements may be provided with a variety of cavity shapes or raised portions and arranged in different patterns. Triangular shapes are particularly adaptable to this configuration.

A simple form of the die, illustrated in FIGURE 13, uses base elements **136** which are similar to the box portions of base elements **12**, but omitting the base flanges. These flangeless base elements **136** are secured directly on bed plate **10** in an alternating arrangement and the spaces are filled by insert elements **18**. To facilitate assembly the base elements **136** are shown as converging slightly toward their upper ends, that is, the sides **138** are inclined inwardly and upwardly. The sides **140** of insert elements **18** are correspondingly inclined inwardly and downwardly. The taper need only be on the order of a few thousandths of an inch, merely enough to facilitate insertion of the insert elements between the secured base elements. Screws **24** will wedge the insert elements firmly in place between the base elements and seated on the bed plate. This simple form has one advantage over the flanged base element assembly, in that a small die can be made, not limited to the basic three units plus multiples of two necessary when the flanges must be accommodated. The tapered side configuration is adaptable to all forms of the die elements.

Since the die elements can be readily produced in quantity by casting or molding, it is desirable to minimize tolerance requirements. The most critical fit in the assembled die occurs at the upper edges of the box portions, where gaps between adjacent elements would cause corresponding ridges in the formed panels. To ensure close fitting without impractical manufacturing precision, the die elements may be made as shown in FIGURE 14, which use base elements **12** and insert elements **18** as examples, although the configuration is applicable to all die elements. Insert element **18** has the tapered sides **140**, as shown in FIGURE 13, while the base elements **12** have correspondingly tapered sides **142**. At the upper edges of sides **140** the taper is increased so that the upper edges of box portion **36** have widened portions **144**. Similarly, at the upper edges of sides **142** the taper is decreased to provide widened portions **146**. The widening is on the order of one or two thousandths of an inch in each case, merely enough to ensure a tight fit. Since the widening occurs around the edges of cavities the die elements will normally accommodate any very slight distortion occurring by the tight fitting, without affecting the formed panel. The technique of laying out an initial framework of base elements ensures uniformity throughout the die, and eliminates the possibility of progressive or accumulative misalignment or error which could occur if the elements were merely assembled in rows across the die.

As illustrated the basic die is suitable for vacuum or pressure forming of sheet material, or for pressing into deformable material. By adding barriers or walls around the die a panel could be made by pouring in liquid material which can be hardened. Further, the die can be adapted to injection molding by securing a plate over the die at the required spacing, or even by using a complementary die built up in the same manner and dimensioned to provide the necessary wall thickness in the panel. All the techniques are well known and are mentioned to indicate the adaptability of the modular die construction.

It is understood that minor variation from the form of the invention disclosed herein may be made without departure from the spirit and scope of the invention, and

that the specification and drawings are to be considered as merely illustrative rather than limiting.

I claim:

1. A modular die, comprising:

a rigid bed plate;

a plurality of die elements each incorporating a specific shaped portion of the die and being individually secured to said bed plate, said die elements interfitting closely in abutting relation and forming a composite die structure;

said die elements including

(a) base elements adapted for initial securement to the bed plate in a predetermined overall pattern, thereby providing a basic fixed framework for the die and preventing accumulative error across the composite die during the assembly thereof; and

(b) insert elements secured between said base elements.

2. The structure according to claim 1 and further including edge elements interfitting with said base and insert elements along at least portions of the die, said edge elements having edge forming portions abutting in continuous relation.

3. The structure according to claim 2 and further including corner elements interfitting with said base and insert elements at corners of the composite die, said corner elements having edge forming portions continuous with the corresponding portions of said edge elements.

4. The structure according to claim 1, wherein said base elements have base flanges extending from the lower portions thereof, the base flanges of adjacent base elements abutting and spacing the base elements apart at the correct distance to receive said insert elements in close fitting inter-relation, and said insert elements resting on said flanges.

5. The structure according to claim 4 and further including edge elements partially overlapping said base flanges along the edges of the die, said edge elements having dropped portions externally of and equal in thickness to said base flanges, whereby the edge elements rest on the base flanges and said bed plate.

6. The structure according to claim 1, wherein the outer sides of said base elements converge upwardly from said bed plate, the outer sides of said insert element being correspondingly divergent, whereby the insert elements fit in tightly wedging relation between the base elements.

7. The structure according to claim 6, wherein at least portions of the upper peripheries of said base elements and insert elements are outwardly thickened to bind tightly against each other when assembled.

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U.S. Cl. X.R.

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