CLAIMS

1. A method for manufacturing a Z-directed component for insertion into a mounting hole in a printed circuit board, comprising:

punching a plurality of segments out of at least one sheet of substrate material to form a plurality of layers of the Z-directed component;

forming a channel through the substrate material, at least one of the formed layers including at least a portion of the channel;

applying a conductive material to at least one surface of at least one of the formed layers; and

combining a stack of the formed layers to form the Z-directed component.

2. The method of claim 1, wherein punching the plurality of segments includes punching each segment into a respective cavity in a respective die block and further comprising stacking the die blocks on top of each other to stack the punched segments.

3. The method of claim 1, wherein punching the plurality of segments includes:

punching a first segment of substrate material into a cavity in a die block having a raisable elevator therein;

lowering the elevator to create additional space in the cavity on top of the first punched segment; and

punching the second segment into the additional space in the cavity to stack the second punched segment on the first punched segment.

4. The method of claim 1, wherein at least a portion of the segments are punched into a respective cavity that is shaped to matably receive the punched layer.

5. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes:

applying a mask to a top surface of the at least one formed layer that restricts the application of conductive material to selected portions of the at least one formed layer; and

screening conductive material through the mask onto the at least one formed layer.

6. The method of claim 5, wherein the mask includes a physical mask placed on the top surface of the at least one formed layer.

7. The method of claim 5, wherein the mask includes a photoresist layer applied to and developed on the top surface of the at least one formed layer.

8. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes spin coating a top surface of the at least one formed layer with liquid conductive material and then selectively etching conductive material from the top surface of the at least one formed layer.

9. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes applying a seed layer of conductive material onto a predetermined portion of the at least one formed layer and then applying additional conductive material by an electrolysis technique.

10. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes:

positioning the at least one formed layer in a constraining plate having a side wall surface that is spaced from a side wall channel in the at least one formed layer forming a gap therebetween; and

applying conductive material in the gap formed between the side wall surface of the constraining plate and the side wall channel in the at least one formed layer to plate the side wall channel in the at least one formed layer with the conductive material.

11. The method of claim 1, wherein combining the formed layers to form the Z-directed component includes heating and compressing the stacked layers to form an aggregate part.

12. The method of claim 11, wherein the layers are compressed with a plug that includes a recess formed in an end thereof having a tapered rim around a periphery of the recess that forms a corresponding taper in at least one of a top surface and a bottom surface of the Z-directed component when the stack of formed layers is combined.

13. A method for manufacturing a Z-directed component for insertion into a mounting hole in a printed circuit board, comprising:

punching a segment out of a sheet of substrate material to form a layer of the Z-directed component;

forming a channel through the substrate material, the formed layer including at least a portion of the channel;

applying a conductive material to at least one surface of the formed layer;

punching additional segments out of at least one of the same sheet and a different sheet of substrate material to form additional layers of the Z-directed component; and

stacking and combining the formed layers to form the Z-directed component.

14. The method of claim 13, wherein stacking the formed layers includes punching each segment into a respective cavity in a respective die block and successively stacking the die blocks on top of each other to stack the punched segments.

15. The method of claim 13, wherein stacking the formed layers includes punching each segment into a cavity in a die block having a raisable elevator therein and lowering the elevator after each segment is punched to create space in the cavity for the next punched segment.

CLAIMS

1. A method for manufacturing a Z-directed component for insertion into a mounting hole in a printed circuit board, comprising:

punching a plurality of segments out of at least one sheet of substrate material, the plurality of punched-out segments form a plurality of layers of the Z-directed component;

forming a channel through the substrate material, at least one of the formed layers including at least a portion of the channel;

applying a conductive material to at least one surface of at least one of the formed layers; and

combining a stack of the formed layers to form the Z-directed component.

2. The method of claim 1, wherein punching the plurality of segments includes punching each segment into a respective cavity in a respective die block.

3. The method of claim 2, further comprising stacking the die blocks on top of each other to stack the punched segments.

4. The method of claim 1, wherein punching the plurality of segments includes:

punching a first segment of substrate material into a cavity in a die block having a raisable elevator therein;

lowering the elevator to create additional space in the cavity on top of the first punched segment; and

punching the second segment into the additional space in the cavity to stack the second punched segment on the first punched segment.

5. The method of claim 1, wherein at least a portion of the segments are punched into a respective cavity that is shaped to matably receive the punched layer.

6. The method of claim 1, wherein the channel through the substrate material is formed before punching the plurality of segments out of the at least one sheet of substrate material.

7. The method of claim 1, wherein the plurality of segments are punched out of the at least one sheet of substrate material before forming the channel through the substrate material.

8. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes:

applying a mask to a top surface of the at least one formed layer that restricts the application of conductive material to selected portions of the at least one formed layer; and

screening conductive material through the mask onto the at least one formed layer.

9. The method of claim 8, wherein the mask includes a physical mask placed on the top surface of the at least one formed layer.

10. The method of claim 8, wherein the mask includes a photoresist layer applied to and developed on the top surface of the at least one formed layer.

11. The method of claim 10, wherein screening conductive material through the mask onto the at least one formed layer includes spin coating liquid conductive material on top of the photoresist layer.

12. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes spin coating a top surface of the at least one formed layer with liquid conductive material and then selectively etching conductive material from the top surface of the at least one formed layer.

13. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes selectively jetting the conductive material onto the at least one formed layer.

14. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes applying a seed layer of conductive material onto a predetermined portion of the at least one formed layer and then applying additional conductive material by an electrolysis technique.

15. The method of claim 1, wherein applying the conductive material to the at least one surface of the at least one formed layer includes:

positioning the at least one formed layer in a constraining plate having a side wall surface that is spaced from a side wall channel in the at least one formed layer forming a gap therebetween; and

applying conductive material in the gap formed between the side wall surface of the constraining plate and the side wall channel in the at least one formed layer to plate the side wall channel in the at least one formed layer with the conductive material.

16. The method of claim 1, wherein combining the formed layers to form the Z-directed component includes heating and compressing the stacked layers to form an aggregate part.

17. The method of claim 16, wherein the layers are compressed with a plug that includes a recess formed in an end thereof having a tapered rim around a periphery of the recess that forms a corresponding taper in at least one of a top surface and a bottom surface of the Z-directed component when the stack of formed layers is combined.

18. The method of claim 1, further comprising:

inserting the Z-directed component into the mounting hole in the printed circuit board; and

applying an adhesive to a surface of the printed circuit board external to the mounting hole, the adhesive contacting a surface of the Z-directed component when the Z-directed component is inserted into the mounting hole to prevent rotational and translational movement of the Z-directed component relative to the printed circuit board after insertion.

19. The method of claim 1, further comprising forming a strip of conductive material along a side surface of the formed Z-directed component that connects to one of a top surface and a bottom surface of the Z-directed component to form a conductive bridge between the respective top or bottom surface of the Z-directed component and a trace on the printed circuit board.

20. A method for manufacturing a Z-directed component for insertion into a mounting hole in a printed circuit board, comprising:

punching a segment out of a sheet of substrate material, the punched-out segment forms a layer of the Z-directed component;

forming a channel through the substrate material, the formed layer including at least a portion of the channel;

applying a conductive material to at least one surface of the formed layer;

punching additional segments out of at least one of the same sheet and a different sheet of substrate material, the additional punched-out segments form additional layers of the Z-directed component; and

stacking and combining the formed layers to form the Z-directed component.

21. The method of claim 20, wherein stacking the formed layers includes punching each segment into a respective cavity in a respective die block and successively stacking the die blocks on top of each other to stack the punched segments.

22. The method of claim 20, wherein stacking the formed layers includes punching each segment into a cavity in a die block having a raisable elevator therein and lowering the elevator after each segment is punched to create space in the cavity for the next punched segment.

23. A method for manufacturing a Z-directed component for insertion into a mounting hole in a printed circuit board, comprising:

forming a channel through a first sheet of substrate material;

applying a conductive material to a predetermined portion of the first sheet;

stacking the first sheet with additional sheets of substrate material;

punching segments out of the stacked sheets, the punched-out segments form a plurality of stacked layers of the Z-directed component, the punched-out segment from the first sheet including at least a portion of the channel and the conductive material on a surface thereof; and

combining the stacked layers to form the Z-directed component.