



"METHOD OF PUNCHING A LAMINATE FOR
ELECTRICAL USE."

The present invention relates to a method of punching a laminate for electrical use, such as insulated laminate, copper clad laminate, printed circuit board or printed wiring board, and particularly to a method of
5 punching a laminate for electrical use which is suitable for preventing occurrence of defects in punching operation such as generation of cracks between the punched holes.

In a prior art punching device of a laminate for electrical use, an oil actuated holding force is
10 applied in the punching device during the time punching operation is effected in order to prevent generation of cracks extending from the punched holes, bends thereabout and separation of laminated layers of the laminate for electrical use.

15 With such a process of punching holes using the above described punching device, however, no measure has been taken to prevent cracks from being generated between adjacent holes punched in the laminate for electrical use in the case where the distance therebetween is small.

20 Further, since punching of holes in the laminate for electrical use has been effected after heating the laminate to a high temperature (60-80°) in order to prevent generation of cracks between adjacent holes, the accuracy in the distance between the centers of the punched
25 holes tends to deteriorate due to shrinkage of the laminate

after the temperature of the board descends. Further, the requirements such as a pressure applied by a hold down for preventing generation of cracks other than cracks between adjacent holes, shear droop and separation of laminated layers of the laminate for electrical use occurring during the punching operation have not been clarified.

It is an object of the present invention to solve the problems occurring in the above described prior art technique and to prevent cracks from being generated between adjacent holes in a laminate for electrical use by applying a predetermined pressure to the laminate during the punching operation thereof, while punching operation is effected at the room temperature so as to dispense with heating of the laminate and to enhance the accuracy in size of the punched holes as well as the productivity thereof.

According to the present invention there is provided a method of punching holes in a laminate for electrical use by using a punching device comprising punches, dies and a hold down, said method including the step of setting the pressure applied to the laminate by means of said hold down in order to hold down the laminate, to be equal to or greater than 0.2 of the ratio of the pressure divided by the tensile strength of said laminate.

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The set pressure may be applied in the region around the respective punched hole in the laminate concentric therewith, said region having an area having a radius equal to or greater than the radius of said punched hole.

The present invention will now be described in greater detail by way of example with reference to the accompanying drawings, wherein:-

Fig. 1 is a side view partly in cross-section showing a punching device of a laminate for electrical use to which a method of punching operation according to the present invention is applicable;

Fig. 2 is a plan view showing the cracks generated in a laminate for electrical use;

Fig. 3 is a side view partly in cross-section showing the flow of material generated in a laminate for electrical use during the punching operation;

Fig. 4 is a plan view showing a circumferential stress generated in a laminate for electrical use during the punching operation;

Fig. 5 is a diagram showing a rate of generation of cracks between the adjacent holes punched in a laminate for electrical use;

Fig. 6 is a cross-sectional view showing a blank holder used in varying the pressure given applied

to a laminate for electrical use; and

Fig. 7 is a graph showing the rate of generation of cracks between adjacent holes in percentage plotted to a base of the outer diameter of the hold down 5 divided by the diameter of the hole.

Referring to Fig. 1, the punching device comprises a lower die set 1, upper die set 2 vertically movably supported by posts 3 fixedly secured to the lower die set 1 with compression springs 4 arranged around the respective posts 3, a die 5 secured to the lower die set 1 and having through-holes 5a formed therein, and punches 6 secured to the upper die set 2 in facing relationship to the through-holes 5a die 5 with a backing plate 7 and a punching plate 8 arranged for securing the punches 6 in position. A hold down 9 is secured at the lower tip of each rod 10 which is suspended from the upper die set 2, and the blank holder 9 is formed with guide holes 9a each position in alignment with the respective through-hole 5a. A laminate for electrical use 11 is interposed in position between the die 5 and the hold down 9, and holding force applying rods 12 pass through the upper die set 2, the backing plate 7 and the punch plate 8 with the tips thereof contacting with the board holder 9.

When the punching operation of the laminate 11 is carried out by using the punching device for the

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laminates constructed as described above, the punching device is secured to a bolster (not shown) of a press, and a punching force F_1 necessary for punching holes in the laminate 11 is applied to the upper die set 2 and, at the same time, a holding down force F_2 is applied to the holding force applying rods 12. In the above described condition in which the hold down 9 is pressed against the laminate 11 with the above described holding force F_2 , the punches 6 pass through the printed board 11 after passing through the guide holes 9a of the hold down 9 by the punching force F and enter into the through-holes 5a in the die 5. Thus, holes of the predetermined sizes are formed in the laminate for electrical use 11.

The present invention is not affected by the kind of pressure applying apparatus used and any apparatus such as a oil type double-acting press can be used insofar as the apparatus can apply the punching force F_1 as well as the hold down force F_2 .

In the above described embodiment, under the condition that the pressure applied to the hold down 9 was set to be 0 kgf/mm^2 and the ratio d/t of the diameter d of the punched hole with respect to the thickness t of the laminate for electrical use 11 was varied, and cracks 14 were generated around the punched holes 13 in the direction of the thickness of the board 11 as shown in

Fig. 2. The cracks 14 render the laminate 11 to be inferior in that they deteriorate the electric characteristics, particularly, the insulation resistance between the adjacent holes 13, 13 in the laminate 11 and tend to cause short-circuiting between the wiring on the laminate.

As a result of investigation in detail of the process of punching for finding out the cause of generation of the cracks 14, the horizontal or the lateral flow 15 of material of the laminate is made larger as shown in Fig. 3 when the ratio d/t of the laminate 11 is small, and the annular projection 16 generated around the respective hole 13 is made larger in proportion to the amount of the lateral flow of the material. Thus, it has been found out the circumferential stress σ_{θ} around the respective punched hole 13 caused by the operation of the punch 6 is made greater to develop crevices perpendicular to the stress σ_{θ} to form the above cracks 14 (Fig. 2).

As to the countermeasure against generation of the above cracks, it is deemed effective to suppress the annular projection 16 around the punched hole 13 by applying the blank holder pressure of the hold down 9 against the laminate for electrical use 11 so as to reduce the circumferential stress σ_{θ} which is the cause of generation of the cracks.

Upon investigation of generation of the cracks 14

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(Fig. 2) in using the punch 6 of the punching device shown in Fig. 1, wherein the one side clearance between the punch 6 and the die 5 is set to be 5% and the holding force F_2 is varied, results as shown in Fig. 5 are obtained. Fig. 5 shows the ratio of the pressure (q) applied to the laminate by means of the hold down in order to hold the laminate with respect to the tensile strength (σ_B) in the abscissa and the ratio of the diameter (d) of the punched hole 13 in the laminate 11 at the time of occurrence of the cracks between the adjacent holes with respect to the thickness (t) of the laminate 11 in the ordinate. The curves $A(\frac{P-d/2}{d/2} = 3.0)$, $B(\frac{P-d/2}{d/2} = 4.0)$ and $C(\frac{P-d/2}{d/2} = 5.0)$ show the rate of generation of the cracks, respectively. The above referred to pressure q is the value of the holding down force F_2 divided by the contact area of the printed board 11 with the hold down 9, and P is the pitch between the adjacent punched holes 13, 13.

As is clear from Fig. 5, when the pressure q is set to 0.2 of the ratio of the pressure divided by the tensile strength σ_B of the laminate 11, generation of cracks 14, 14 between adjacent holes 13, can be positively prevented.

Further, a rate of generation of cracks was investigated within the region in which the effective holding down function is obtained by using a hold down 17 having an annular concentric projection 17b of the

height of 1 mm and the diameter of D concentric with the guide hole 17a formed at one side (at the side facing to the laminate for electrical use) and setting the pressure q to be a constant value of 0.2 of the ratio of the pressure divided by the tensile strength of the printed board, the diameter D being varied for the investigation.

The results of the investigation are as shown in Fig. 7. Fig. 7 shows the rate of generation of cracks (%) in the ordinate and the ratio of the outer diameter (d) of the guide hole in the abscissa, and the influence of the area of the blank holder 17 in which the pressure q is applied to the laminate by means of the hold down for electrical use q given to the rate of generation of the cracks is shown in Fig. 7. It is clear from the curve E ($\frac{\text{pressure } q}{\text{tensile strength}} = 0.2$) in Fig. 7 that the effective region in which the pressure q effectively prevents generation of cracks is the region having the radius of at least twice the radius of each punched hole of the laminate 11, while the pressure q equal to or greater than 0.2 of the ratio of pressure divided by the tensile strength of the laminate is required for preventing the generation of cracks.

As described above, since the punching operation can be carried out at the room temperature according to the method of the present invention, shrinkage of the distance between the center of hold down caused by the

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heating during the punching operation is positively avoided, while cracks which might be generated between adjacent holes in the laminate for electrical use during the punching operation is prevented so that accuracy in
5 the size of the holes and the productivity are enhanced.



CLAIMS:-

1. A method of punching holes in a laminate for electrical use by using a punching device comprising punches, dies and a hold down, said method including the step of setting the pressure applied to the laminate by means of said hold down in order to hold down the laminate, to be equal to or greater than 0.2 of the ratio of the pressure divided by the tensile strength of said laminate.
2. A method of punching a laminate for electrical use according to claim 1, wherein said set pressure is applied in the region around the respective punched hole in the laminate concentric therewith, said region having an area having a radius equal to or greater than the radius of said punched hole.
3. A method of punching holes in a laminate for electrical use, wherein punches are actuated for punching said holes while a pressure equal to or greater than 0.2 of the ratio of pressure to the tensile strength of said laminate is applied over a region having the radius of at least twice the radius of said punched hole from the center thereof.
4. A method of punching a laminate for electrical use according to claim 3, wherein said pressure is applied by annular projections formed on a hold down around the respective hole for holding said laminate.



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5. A method of punching holes in a laminate for electrical use, substantially as herein described with reference to and as shown in the accompanying drawings.
