small-diameter drill for a wired printed plate and general thinning is performed on the drill preventing the drill made from cemented carbide from chipping in order to drill holes on a resin board including glass fiber. Additionally, the drill described in the following patent document 1 is a twist drill which has x shape thinning.

[0007]

Thinning has been performed on every drills described in the patent documents 1, 3, and 4, but the thinning was not done for decreasing drilling resistance. Therefore, in some cases, drilling resistance may be increased but not decreased by its thinning and thus these drills cannot obtain acceptably high efficiency enough to drill holes taking advantage of manpower, such as a hand drill.

[Prior-Art Documents]

[Patent documents]

[0008]

Patent document 1: Tokukai 2000-271811

Patent document 2: Tokukai 2006-88267

Patent document 3: Tokukaihei 7-40119

Patent document 4: Tokukaihei 7-164228

[SUMMARY OF THE INVENTION]

[Problems to be solved by the Invention]

[0009]

The present invention is made to solve the problems of above-described Prior-Art, and proposes a drill which can substantially decrease drilling resistance, and allow for easy hole-drilling by manpower using a hand drill, a drill press, and the like.

[Means for solving the problems]

[0010]

The present invention according to claim 1 relates to a drill with a tip part on which thinning is performed, comprising two cutting blades which are formed symmetrical about an axis of rotation, said cutting blades consisting of a thinning cutting blade extending from a chisel edge toward a peripheral side of the drill to become a shape including curves when seen from tip side of the drill, and a main cutting blade extending from an end part of said thinning cutting blade to the peripheral end of the drill, wherein a ridge line of a boundary between a slot for emitting chips and a thinning surface shaped by said thinning cutting blade is

substantially u-shaped, inclining toward the drill axis direction and toward a direction in which the ridge line moves from the thinning cutting blade side to the main cutting blade side as it moves from the drill's tip side to the base end side, when seen from front side of the drill which is an aperture side of said slot, and wherein a rake angle θ1 formed by said main cutting blade and a rake angle θ2 formed by said thinning cutting blade satisfy $\theta1>\theta2>0°$, except for a part just below the chisel.

[0011]

The present invention according to claim 2 relates to the drill of claim 1, wherein an extension line extending in a drill tip direction a line along the deepest portion of said thinning surface is offset to heel side or cutting blade side of the drill, without crossing the central part of the drill tip, when seen from said front side of the drill.

[0012]

The present invention according to claim 3 relates to the drill of claim 2, wherein width of said offset is equal to or smaller than 10% of a drill diameter.

[0013]

The present invention according to claim 4 relates to the drill of claim 2 or 3, wherein said extension line is offset to the heel side of the drill.

[0014]

The present invention according to claim 5 relates to the drill of claim 2 or 3, wherein said extension line is offset to the cutting blade side of the drill.

[0015]

The invention according to claim 6 relates to the drill of claim 1, wherein an extension line extending in a drill tip direction a line along the deepest portion of said thinning surface crosses the central part of the drill tip, when seen from said front side of the drill.

[0016]

The present invention according to claim 7 relates to the drill of claims 2 to 4, wherein a rake angle is formed in a part including a part just below the chisel of said thinning cutting blade.

[0017]

The present invention according to claim 8 relates to the drill of any of claims 2, 3, 5, and 6, wherein a rake angle is formed in a part which is adjacent to but does not include a part just

below the chisel of said thinning cutting blade.

[0018]

(Canceled)

[0019]

According to the invention of claim 1, there is a drill provided which can substantially decrease cutting resistance compared with the conventional drill and can easily drill holes by manpower using a hand drill, a manual drill press, or the like. Moreover, the reduction of cutting resistance improves drilling accuracy and reduces the time to drill holes, leading to improvement of working efficiency. Furthermore, it also allows for significant increase in the drill's life span. Besides, a rake angle θ_1 formed by said main cutting blade and a rake angle θ_2 formed by said thinning cutting blade satisfy $\theta_1 > \theta_2$, except for a part just below the chisel. Therefore, an apparent rake angle becomes smaller and the less portion of the blade edge digs deep into the workpiece, thereby making the cutting blade much easier to drill even if the drill is pressed against the workpiece by manpower such as a hand drill. Moreover, setting $\theta_2 > 0°$ prevents any failure as occurred if $\theta_2 \leqq 0°$ is set (as the cutting resistance increases, the sharpness deteriorates).

[0020]

According to the invention of claim 2, an extension line extending in a drill tip direction a line along the deepest portion of said thinning surface is offset to heel side or cutting blade side of the drill, without crossing the central part of the drill tip, when seen from front side of the drill. Therefore, a distinct rake part can be formed from chisel to the cutting blade (including a portion of the heel part, too), or from chisel neighborhood, except for just below the chisel, to the cutting blade. This leads to significant improvement of sharpness of the cutting blade.

[0021]

According to the invention of claim 3, width of said offset is equal to or smaller than 10% of a drill diameter and therefore the drilling resistance can be more surely decreased, which drastically improves high efficiency of the cutting blade.

[0022]

According to the invention of claim 4, said extension line is offset to the heel side of the drill, and therefore a distinct rake part can be formed from chisel to the cutting blade (including a portion of the heel part, too). This results in a distinct cutting blade from the chisel part to the cutting blade part, and its

drilling efficiency significantly improves. Furthermore, the drilling force obtained from the rotation of the drill generates from the moment the drill tip contacts a workpiece (since a rake is also provided at the drill tip, component force for the rake angle generates even by for example rotation of an air drill from the moment the drill contacts the workpiece, and this component force affects the workpiece), and the power which an operator needs to apply on the drill may be smaller. Additionally, the rake angle becomes comparatively larger and the drilling force becomes the largest, compared with the cases where said extension line is offset to the cutting blade side of the drill and where said extension line crosses the central part of the drill tip.

[0023]

According to the invention of claim 5, said extension line is offset to the cutting blade of the drill, and therefore a distinct rake is obtained from the chisel neighborhood to the cutting blade, except for a part just below the chisel. Although there is no rake provided just below the chisel, the chisel width is much narrower than if said extension line is offset to the heel side (case 1), and the chisel width is substantially same as in the case said extension line crosses the central part of the drill tip (case 2). In addition, since a larger thinning part can be formed, drilling resistance can be decreased and the high efficiency equal to or greater than that of the above-described two cases (cases 1 and 2) can be obtained even if no rake is provided just below the chisel.

[0024]

According to the invention of claim 6, the extension line extending in a drill tip direction a line along the deepest portion of said thinning surface crosses the central part of the drill tip, when seen from front side of the drill. Therefore, a distinct cutting blade is shaped from the chisel neighborhood, except for a part just below the chisel, to the cutting blade part and the high drilling efficiency will significantly improve. Since the chisel width is reduced to a minimum, drilling resistance decreases instead and the same drilling force as obtained if said extension line is offset to the heel side, can be obtained.

[0025]

According to the invention of claim 7, a rake angle is formed in a part including a part just below the chisel of a thinning cutting blade. Therefore, the invention has the advantage that a rake angle is formed across all the parts contacting the workpiece from a part just below the chisel to the cutting blade, and all the parts serve as cutting blade, thereby increasing the drilling force (see the below-described figure 12 (a)).

[0026]

According to the invention of claim 8, a rake angle is formed in a part which is adjacent to but does not include a part just below the chisel of said thinning cutting blade, and therefore the part contacting the workpiece, except for a part just below the chisel, serves as cutting blade. Although this can generate a drilling force a bit smaller than the force generated in the case if a rake angle is formed in a part including a part just below the chisel of a thinning cutting blade (case 3), a chisel tip part becomes narrower and the drilling resistance on the chisel tip part decreases, thereby obtaining the same drilling efficiency as obtained in the case 3 (see the below-described figure 12 (b) and (c)). In addition, comparing with the case 3, this has the advantage that a thinning part can be much wider. Therefore, a thinning position can be changed and adjusted in accordance with workpiece materials and the drill diameter. Some ingenuity can be added. For example, if the workpiece is made of relatively hard materials or the drill diameter is larger, the thinning position can be moved to the cutting blade, and if the workpiece is made of soft materials or the drill diameter is smaller, the thinning position can be moved to the heel side.

[0027]

(Canceled)

small-diameter drill for a wired printed plate and general thinning is performed on the drill preventing the drill made from cemented carbide from chipping in order to drill holes on a resin board including glass fiber. Additionally, the drill described in the following patent document 1 is a twist drill which has x shape thinning.

[0007]

Thinning has been performed on every drills described in the patent documents 1, 3, and 4, but the thinning was not done for decreasing drilling resistance. Therefore, in some cases, drilling resistance may be increased but not decreased by its thinning and thus these drills cannot obtain acceptably high efficiency enough to drill holes taking advantage of manpower, such as a hand drill.

[Prior-Art Documents]

[Patent documents]

[0008]

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[SUMMARY OF THE INVENTION]

[Problems to be solved by the Invention]

[0009]

The present invention is made to solve the problems of above-described Prior-Art, and proposes a drill which can substantially decrease drilling resistance, and allow for easy hole-drilling by manpower using a hand drill, a drill press, and the like.

[Means for solving the problems]

[0010]

The present disclosure provides a drill with a tip part on which thinning is performed, comprising two cutting blades which are formed symmetrical about an axis of rotation,

said cutting blades consisting of a thinning cutting blade extending from a chisel edge toward a peripheral side of the drill to become a shape including curves, and a main cutting blade extending from an end part of said thinning cutting blade to the

peripheral end of the drill, when seen from tip side of the drill,

wherein a ridge line of a boundary between a slot for emitting chips and a thinning surface shaped by said thinning cutting blade is substantially u-shaped, inclining toward the drill axis direction and toward a direction in which the ridge line moves from the thinning cutting blade side to the main cutting blade side as it moves from the drill's tip side to the base end side, when seen from front side of the drill which is an aperture side of said slot, and

wherein a rake angle θ1 formed by said main cutting blade and a rake angle θ2 formed by said thinning cutting blade satisfy $\theta1>\theta2>0°$, except for a part just below the chisel.

[0011]

An extension line extending in a drill tip direction a line along the deepest portion of said thinning surface may be offset to heel side or cutting blade side of the drill, without crossing the central part of the drill tip, when seen from front side of the drill.

[0012]

A width of said offset may be equal to or smaller than 10% of a drill diameter.

[0013]

The extension line may be offset to the heel side of the drill.

[0014]

The extension line may be offset to the cutting blade side of the drill.

[0015]

An extension line extending in a drill tip direction a line along the deepest portion of said thinning surface may cross the central part of the drill tip, when seen from front side of the drill.

[0016]

A rake angle may be formed in a part including a part just below the chisel of said thinning cutting blade.

[0017]

A rake angle may be formed in a part which is adjacent to but does not include a part just below the chisel of said thinning

cutting blade.

[0018]

As mentioned above, a rake angle θ_1 is formed by said main cutting blade and a rake angle θ_2 formed by said thinning cutting blade satisfy $\theta_1>\theta_2>0°$, except for a part just below the chisel.

[Effects of The Invention]

[0019]

The drill provided above can substantially decrease drilling resistance compared with the conventional drill and can easily drill holes by manpower using a hand drill, a manual drill press, or the like. Moreover, the reduction of drilling resistance improves drilling accuracy and reduces the time to drill holes, leading to improvement of working efficiency. Furthermore, it also allows for significant increase in the drill's life span. Besides, a rake angle θ_1 formed by said main cutting blade and a rake angle θ_2 formed by said thinning cutting blade satisfy $\theta_1>\theta_2$, except for a part just below the chisel. Therefore, an apparent rake angle becomes smaller and the less portion of the blade edge digs deep into the workpiece, thereby making the cutting blade much easier to cut even if the drill is pressed against the workpiece by manpower such as a hand drill. Moreover, setting $\theta_2>0°$ prevents any failure as occurred if $\theta_2\leqq 0°$is set (as the drilling resistance increases, the drilling efficiency deteriorates).

[0020]

As described above, an extension line extending in a drill tip direction a line along the deepest portion of said thinning surface may be offset to heel side or cutting blade side of the drill, without crossing the central part of the drill tip, when seen from front side of the drill. Therefore, a distinct rake part can be formed from chisel to the cutting blade (including a portion of the heel part, too), or from chisel neighborhood, except for just below the chisel, to the cutting blade. This leads to significant improvement of sharpness of the cutting blade.

[0021]

As described above, a width of said offset may be equal to or smaller than 10% of a drill diameter and therefore the drilling resistance can be more surely decreased, which drastically improves

high efficiency of the cutting blade.

[0022]

As described above, said extension line may be offset to the heel side of the drill, and therefore a distinct rake part can be formed from chisel to the cutting blade (including a portion of the heel part, too). This results in a distinct cutting blade from the chisel part to the cutting blade part, and its drilling efficiency significantly improves. Furthermore, the drilling force obtained from the rotation of the drill generates from the moment the drill tip contacts a workpiece (since a rake is also provided at the drill tip, component force for the rake angle generates even by for example rotation of an air drill from the moment the drill contacts the workpiece, and this component force affects the workpiece), and the power which an operator needs to apply on the drill may be smaller. Additionally, the rake angle becomes comparatively larger and the drilling force becomes the largest, compared with the cases where said extension line is offset to the cutting blade side of the drill and where said extension line crosses the central part of the drill tip.

[0023]

As described above, the extension line may be offset to the cutting blade of the drill, and therefore a distinct rake is obtained from the chisel neighborhood to the cutting blade, except for a part just below the chisel. Although there is no rake provided just below the chisel, the chisel width is much narrower than if said extension line is offset to the heel side (case 1), and the chisel width is substantially same as in the case said extension line crosses the central part of the drill tip (case 2). In addition, since a larger thinning part can be formed, drilling resistance can be decreased and the high efficiency equal to or greater than that of the above-described two cases (cases 1 and 2) can be obtained even if no rake is provided just below the chisel.

[0024]

As described above, the extension line extending in a drill tip direction a line along the deepest portion of said thinning surface may cross the central part of the drill tip, when seen from front side of the drill. Therefore, a distinct cutting blade is

shaped from the chisel neighborhood, except for a part just below the chisel, to the cutting blade part and the high drilling efficiency will significantly improve. Since the chisel width is reduced to a minimum, drilling resistance decreases instead and the same drilling force as obtained if said extension line is offset to the heel side, can be obtained.

[0025]

As described above, a rake angle may be formed in a part including a part just below the chisel of a thinning cutting blade. Therefore, the invention has the advantage that a rake angle is formed across all the parts contacting the workpiece from a part just below the chisel to the cutting blade, and all the parts serve as cutting blade, thereby increasing the drilling force (see the below-described figure 12 (a)).

[0026]

As described above, a rake angle may be formed in a part which is adjacent to but does not include a part just below the chisel of said thinning cutting blade, and therefore the part contacting the workpiece, except for a part just below the chisel, serves as cutting blade. Although this can generate a drilling force a bit smaller than the force generated in the case if a rake angle is formed in a part including a part just below the chisel of a thinning cutting blade (case 3), a chisel tip part becomes narrower and the drilling resistance on the chisel tip part decreases, thereby obtaining the same drilling efficiency as obtained in the case 3 (see the below-described figure 12 (b) and (c)). In addition, comparing with the case 3, this has the advantage that a thinning part can be much wider. Therefore, a thinning position can be changed and adjusted in accordance with workpiece materials and the drill diameter. Some ingenuity can be added. For example, if the workpiece is made of relatively hard materials or the drill diameter is larger, the thinning position can be moved to the cutting blade, and if the workpiece is made of soft materials or the drill diameter is smaller, the thinning position can be moved to the heel side.

[0027]

Notably, a rake angles θ_1 and θ_2 satisfy $\theta_1>\theta_2>0°$, except for a part just below the chisel.

[CLAIMS]

1. ~~(Currently Amended)~~ A drill with a tip part on which thinning is performed, comprising two cutting blades which are formed symmetrical about an axis of rotation,

said cutting blades consisting of a thinning cutting blade extending from a chisel edge toward a peripheral side of the drill to become a shape including curves, and a main cutting blade extending from an end part of said thinning cutting blade to the peripheral end of the drill, when seen from tip side of the drill,

wherein a ridge line of a boundary between a slot for emitting chips and a thinning surface shaped by said thinning cutting blade is substantially u-shaped, inclining toward the drill axis direction and toward a direction in which the ridge line moves from the thinning cutting blade side to the main cutting blade side as it moves from the drill's tip side to the base end side, when seen from front side of the drill which is an aperture side of said slot, and

wherein a rake angle $\theta 1$ formed by said main cutting blade and a rake angle $\theta 2$ formed by said thinning cutting blade satisfy $\theta 1 > \theta 2 > 0°$, except for a part just below the chisel.

2. ~~(Currently Amended)~~ The drill according to claim 1, wherein an extension line extending in a drill tip direction a line along the deepest portion of said thinning surface is offset to heel side or cutting blade side of the drill, without crossing the central part of the drill tip, when seen from said front side of the drill.

3. The drill according to claim 2, wherein width of said offset is equal to or smaller than 10% of a drill diameter.

4. The drill according to claim 2 or 3, wherein said extension line is offset to the heel side of the drill.

5. The drill according to claim 2 or 3, wherein said extension line is offset to the cutting blade side of the drill.

(Amendment under Article 34)

6. ~~(Currently Amended)~~ The drill according to claim 1, wherein an extension line extending in a drill tip direction a line along the deepest portion of said thinning surface crosses the central part of the drill tip, when seen from said front side of the drill.

7. The drill according to any of claims 2 to 4, wherein a rake angle is formed in a part including a part just below the chisel of said thinning cutting blade.

8. The drill according to any of claims 2, 3, 5, and 6, wherein a rake angle is formed in a part which is adjacent to but does not include a part just below the chisel of said thinning cutting blade.

~~9. (Canceled)~~