1 580 220

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO SHAVING WOOD

(71) We, HENDRIK HUPKES and HENK HUPKES both Dutch Subjects of Gaasterland 30, Zoetermeer, The Netherlands and Burg. van Oordstraat 12, Ermelo, The Netherlands, respectively, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for shaving wood, wherein a non-rotary cutter coacts with one or more aids, viz. a sole plate or a pressure bar, and/or a top iron.

The conventional milling and moulding machines all show some serious drawbacks which are caused by the use of rotary cutter blocks. The major drawbacks are:

— the treated surface shows a machine stroke. If a better surface quality is to be achieved, either the feeding speed of the material to be worked should be reduced or an additional after-treatment has to take place by means of an (expensive) scouring process or additionally a thin chip has to be removed by means of a machine operating through non-rotary cutters, such as a fixed-knife box;

— high power consumption per unit area of treated surface and high idling capacity;

— high unsafeness, owing to both the possibility of hawk-in or kick-back of materials and the great centrifugal forces which arise;

— intolerable noise level.

It is obvious to try to eliminate the above drawbacks by using instead of rotary cutter blocks, non-rotary knives, as to be found for instance in knife boxes and block planes.

However, practice has shown that the use of non-rotary knives involves other drawbacks, which are so serious that wood treating machines with rotary cutter blocks are still predominantly in use.

The drawbacks inherent in using stationary knives lie mainly in the field of adjustment of the tool when thick chips or chips of different thickness have to be removed.

When a chip has to be removed by means of a stationary knife, not only the cutting tool has to be set to the proper depth, but also the so-called aids: the top iron and/or the sole plate or the pressure bar have to be set. These aids, individually or in combination, serve to force the removed chip to describe a specific path with a centre of curvature unambiguously defined by the position of said aids, by means of which likewise the length of the rive crack being formed ahead of the cutter is defined. Since the control of the length of said rive crack is highly important for obtaining a worked surface of high quality, also a proper setting of an aid or the aids, is very important.

In this respect it is observed that when use is made of a pressure bar or block in connection with the present apparatus, said pressure bar has the same function as the sole plate. A pressure bar is a body which exerts pressure on the object to be worked, ahead of the cutter. Also by means of a pressure bar the length of the rive crack is limited.

In particular, the adjustment of the aids is very critical when relatively thick chips have to be removed. The rigidity of a chip as a matter of fact is proportional to the cube power of its thickness and this has the result with thick chips that in case of incorrect adjustment of one or more aids, the removed chip "gets stuck", because a long rive crack is produced, as a result of which the surface to be worked can be easily spoiled.

Generally speaking, it may be stated that planing tools having stationary, i.e. non-rotary, cutters are suitable for removing relatively thin chips and that with increasing chip thickness, the difficulties encountered during the setting increase enormously. The result is that this type of tool has many drawbacks when used for removing thick chips or for removing chips whose thickness has to be variably adjustable.

It is observed in this respect that the optimal adjustment of the aids can only be successfully effected by skilled workers and that even then the result has to be checked mostly by means of test planing.

It is the object of the invention to eliminate the above mentioned drawbacks which occur during planing by means of tools having non-rotary cutters, thereby to create the possibility

of using stationary cutters for performing working steps hitherto effected by means of rotary cutter blocks.

The apparatus according to the invention is characterized by means for adjusting the depth of the cutting tool to remove chips of different thickness, and means for simultaneously adjusting the aid relative to the tool so that upon adjustment of the cutting tool to remove a chip of desired thickness the aid is also adjusted so that the centre of curvature of the path traversed by the removed chip always lies on a line for causing an optimum rive crack as herein defined associated with the desired chip thickness.

As a result of the, for instance mechanical, coupling between the cutting tools and the aid(s), care being taken that this coupling is performed so that there is obtained with each chip thickness the optimum rive crack, namely a rive crack which is shorter than a rive crack that will produce a riven chip and longer than a rive crack that will lead to a stripped chip, it has been found possible to adjust the tool in a very simple manner for each desired chip thickness. In particular this is important when removing thick chips. Skill and/or checking of the setting by means of a test are not required with the apparatus according to the invention.

As already observed, the above coupling is such that for each chip thickness the centre of curvature of the path of the removed chip lies on a predetermined line for causing an optimum rive crack.

The concept that by selecting as the path of adjustment for e.g. the top iron, a specific, for instance straight, path of adjustment, and incorporating same as a standard path of adjustment when working a specific material in the working process, while coupling same to the depth adjustment of the cutting tool, there is no longer question of elaborate adjustment, while yet an optimum result is achieved, is to be considered a surprising development in the domain of planing by means of stationary cutters. The invention opens new ways in this field of technology.

In one embodiment of the apparatus which includes a sole plate, the adjusting means is arranged to move the cutting tool from a zero position in which no chip is removed and a position corresponding to the desired chip thickness so that the cutting edge of the tool traverses a path which lies in the acute angle between the downward prolongation of the bisector of the angle between the sole plate and the upper face of the cutting tool in the zero position and the sole plate, and so that the rake angle of the tool is maintained substantially constant, the rake angle being the angle between the upper face of the tool and a plane perpendicular to the sole plate through the cutting edge of the tool.

That the adjustment path of the cutting tool lies within the above described angle is caused by the condition that, when chip thickness is increasing, the distance between the cutting edge of the tool and the edge of the sole plate — the gap width — should at least be equal to the chip thickness.

Shaving takes place only when the set depth of the cutting tool exceeds a zero position which is characteristic of the material to be worked to allow for the spring-back which every material possesses.

It is observed that the path of adjustment of the tool point may be a straight line, a concave or convex curve or any combination.

The paths of adjustment of the cutting tool and those of either the sole or pressure bar, or the top iron, or both are so coupled together that the required optimum rive crack is always produced.

For instance, in an apparatus which, like a conventional block plane, comprises a sole plate and a top iron, abutting against the cutting tool, the top iron always abuts against the upper face of the tool at a constant or substantially constant angle and is adjustable along said face. The adjustment paths of the cutting tool and the top iron therefore are coupled to each other in such a way that the straight path of adjustment of the cutting tool leads to a straight or substantially straight path of adjustment of the top iron. The interrelationship between the two adjustment path directions is fixed for each apparatus and therefore is a given data for each apparatus. How this interrelationship is selected depends on the material to be worked.

A preferred embodiment of such an apparatus according to the invention is that the tool is mounted on the back plate of a sole plate comprising front and back plates and is movable as a unit with the back plate. The back sole plate is slidable relative to a block fixedly connected to the front sole plate whereby the back sole plate is adjustable in a direction corresponding to the path of adjustment of the cutting tool, the top iron is mounted on an arm pivotally connected to the block by a pivot pin, and means are provided for clamping the top iron against the upper face of the cutting tool.

By virtue of the attachment of the cutting tool to the back sole plate, so that the tool is set by adjusting the back plate, the advantage of greater accuracy of adjustment is obtained. The attachment of the top iron to a pivoted arm by means of which also the clamping force with which the top iron is always pressed against the cutting tool is transferred, is a simple and effective construction, ensuring a proper adjustment of the top iron. The clamping force, too, can be adjusted in a simple manner. It is true that the top iron does not move exactly at a constant angle, but since the radius of the circle along which the tool edge is moving is so much larger than the path traversed over the circle circumference, the deviation does not effect the required setting,

i.e., the position of the centre of curvature of the path which is followed by the removed chip.

Advantageously the pivot pin is designed so that, in the absence of clamping force, the arm is removable and remountable without disturbing the adjustment of the top iron relative to the cutting tool. The advantage of this feature is that the arm and the pivot pin can be easily removed. When the tool is exchanged, the initial setting of the top iron is thus maintained.

In order to set the cutting tool properly for a specific cutting depth, the block and the back sole plate may be provided with a vernier scale for indicating the depth to which the cutting tool is set. This scale is calibrated with respect to the thickness of the removed chip. In this calibration allowance is made for the so-called spring-back of the surface to be worked. In order that the proper zero position can be easily set, the scale may include one or more marks for zero setting which allow for the occurring spring-backs.

These spring-backs of the surface to be worked differ from material to material. For instance, wet deal may have a spring-back of 0.09 mm, while this value is 0.03 mm for dry oak.

The back sole plate and the block are kept slidably connected by means of one or more resilient retaining clips. The advantage of this feature is that no locking or unlocking is required during the setting.

Although only tools have been mentioned in the foregoing for working plane surfaces, the invention also applies to tools for obtaining profiled surfaces.

The invention also comprises wood working machines wherein one or more cutting tools are employed. For instance, this applies to machines wherein for each operation a plurality of planes are positioned one behind the other. In such machines the "first" planes, which are roughing planes, should never produce a rive crack penetrating into the surface to be eventually obtained: the last plane defines the smoothness of the surface.

The invention also comprises multiple planing machines by means of which both profiled and non-profiled surfaces are realized.

The invention will now be explained, by way of example, with reference to the accompanying drawings, wherein:

Figs. 1, 2, 3 and 4 diagrammatically show the shaving of e.g. wood without an aid and using as an aid a top iron, a sole plate and a pressure bar, respectively;

Fig. 5 diagrammatically shows a method of shaving, using a sole plate and a top iron as aids;

Fig. 6 is a longitudinal section of a block plane according to the invention.

In the Figures corresponding parts, angles etc. are designated by identical reference numerals.

Fig. 1 shows a method of removing a chip, wherein by means of a cutting tool 11, which moves relatively to the wood in the direction of the arrow, a chip 10 is removed from a piece of wood 13. The purpose is to obtain a worked surface 12, starting from the unmachined or roughly-unmachined surface 4.

Wood has the property that it springs back after having been machined. When the cutting tool is set to remove a chip 10 having a desired thickness 2, allowance should be made for said spring-back 14. In the zero-setting, which is the setting at which the cutting tool just does not remove a chip — corresponding to the dotted position of the cutting tool 11a — said spring-back can be found back in the depth at which the tool point is positioned underneath the surface 4 to be worked. Starting from said surface 4, the set depth 3 of the tool therefore is equal to the thickness 2 of the removed chip 10, increased by said spring-back 14.

For setting the tool 11 to the required depth, it is adjusted over e.g. the path of adjustment 34, of which the vertical component, calculated from the zero setting, is equal to the thickness 2 of the removed chip 10.

By 1 is indicated the imaginary surface obtained by extending the worked surface 12.

It is observed that surfaces 1, 4 and 12 are not necessarily plane faces. They may also be curved surfaces with for instance a circular cross-section.

Characteristic of the position of the cutting tool are the clearance angle α, the wedge angle β and the rake angle α.

Ahead of the tool lip there is produced a rive crack 5 having a length 15.

For the sake of clarity of these considerations, the path of the removed chip is always assumed to be circular. This assumption turns out to lead to acceptable results in practice.

The centre 7 of the path followed by the removed chip 10 will lie "somewhere" on the bisector of the angle between the imaginary extended worked surface 12 — i.e. the faces 1 — and the upper face 9 of the tool 11. By this, the location of said centre of curvature 7 is not unambiguously defined. Since the length 15 of the rive crack 5 is defined by the position of said centre of curvature, the length of the rive crack 5 is also indefinite.

It is known that the machining can be influenced by varying the rake angle α. Starting from a small rake angle, and gradually increasing same, there is first produced a so-called deformed chip with no occurrence of a rive crack. The required cutting force is considerable and likewise there is a substantial wear on the cutting edge of the tool. With an increasing rake angle α, the chip form passes into a stripped chip, in which case there is just or just not produced a rive crack. The required cutting force is smaller and the tool wear is less. Upon a further increase of the rake angle,

there occurs a rive crack, during which the resulting surface 12 is no longer substantially defined by the tool, but also the arbitrariness during the splitting plays a role so that the surface quality may be affected.

The apparatus according to the invention works by producing an optimum rive crack, as hereinbefore defined. The setting of the tool to produce the optimum rive crack is very difficult owing to the many variables which play a role.

Since the rive crack formation strongly depends on the rigidity of the chip and said rigidity increases with the cube power of the thickness of the chip, it is not possible to remove thick chips without using aids, i.e., by means of only one tool, and yet obtain a smoothly worked surface.

Fig. 2 diagrammatically shows how a chip 10 may be removed using a top iron 20. The position of the top iron is defined by the iron angel 19 and the free cutting face width 18. When the path of the removed chip 10 is again assumed to be circular, the location of the centre of curvature 7 of the path of the removed chip is determined when top iron 20 and cutting tool 11 have a given position; said centre 7 as a matter of fact lies on the intersection of the bisector of the angle between the face of the tool lip and the surface to be worked — line 16 — and the bisector of the angle between the upper face of the tool lip and the front face of the top iron — line 17. Therefore, by varying the position of the tool, the position of the centre of curvature 7 can be varied and thereby the radius of curvature of the path of the chip, and since said radius of curvature defines the length of the rive crack 5, also said length can be varied and set to a desired magnitude.

Fig. 2 also shows the situation with cutting tool 11*a* and top iron 20*a* in the 0-position. In setting for the required chip thickness, the cutting tool 11*a* is adjusted from said zero position according to the path of adjustment 34, while the top iron 20*a* is adjusted along the path 41, during which the centre of curvature 7*a* moves along the line 23 toward point 7.

Fig. 3 indicates how use is made of a sole plate 22 as an aid for remaining a chip. The sole plate 22 may have a sharp edge, but the front face may also be rounded, e.g. by wear, as shown in the Figure by means of a broken line. The sole plate 22 is set to define a gap width 26, being the distance between the sharp-edged sole plate and the cutting face of the cutting tool 11. Also in such a method the centre of curvature of the path of the removed chip is fixed at a specific position of the aid. Critical here is the position of the edge 21, by means of which the length of the rive crack is defined. Said centre of curvature 7 lies on the intersection of the perpendicular 24 through the edge 21 and the bisector 16.

Instead of by means of a sole plate, the chip thickness may also be determined by means of a pressure bar 30 (see Fig. 4). The drawing shows a pressure bar with a circular cross-section in the region wherein it abuts against the chip, having a centre 32 (by 30*a* is indicated the pressure bar in the 0-position). The smallest distance 27 between the outer surface of the pressure block and the extension of the worked surface is smaller than the cutting depth 2. To avoid stripping up of the chip, the gap width 26 should at least be equal to the chip thickness 2. Here, too, the centre of curvature 7 is fixed, viz. on the intersection of the bisector 16 and the perpendicular 24 through the point of spring-back 31.

Both the setting of the top iron 20 (Fig. 2) and the setting of the sole plate or the pressure block in connection with the gap width for obtaining an optional result is skilled work, for which steps the worker in the art usually resorts to his intuition.

By providing according to the invention for such a coupling between the setting of the cutting tool and the setting of an aid that at a given ratio between the chip thickness and the associated radii of curvature, the paths of adjustment of the aids and of the cutting tool are fixed relative to each other, the above mentioned difficult setting is avoided. Figs. 2, 3 and 4 show that such a coupling can be realized, starting from a given starting situation, for instance the situation wherein only just no chip is removed.

By setting for instance in Fig. 2 the cutting tool 11 for a greater cutting depth 2, at a ratio of the chip thickness to the maximum radius of curvature of 2:3, as shown, at a constant top iron angle 19, the top iron should be set over a path of adjustment 41 along the face of the lip of the cutting tool. A mechanical coupling wherein, when setting for a specific chip thickness, the double iron is automatically adjusted in this manner, can be realized without much difficulty. The associated locus of the centres of curvature is shown at 23.

In the arrangement of Fig. 3 at a given ratio between chip thickness and radii of curvature, a setting for a thicker chip involves a path of adjustment 34 of cutting tool 11. Essential in this respect is that said path of adjustment lies in the acute angle between the downward prolongation of the bisector of the angle between the sole plate 22 and the upper face of the tool 11*a* and the sole plate 22. Here, too, the path of adjustment is fixed in dependence on the depth of setting and therefore a mechanical coupling can be constructed. The centre of curvature then moves along the line of displacement 24.

When using a pressure block according to Fig. 4, this applies analogously.

Fig. 5 diagrammatically shows the procedure when use is made of both a sole plate 22 and a top iron 20, 20*a*, the broken lines again indicating tool and top iron in the zero position, making allowance for a spring-back of the wood. In this case both the top iron and the sole plate play a role in the guiding of the chip. The respective paths of adjustments 34 and 41 of the tool and the top iron can be chosen so that at a given chip thickness, either the one aid or the other, or both equally define the chip form.

Generally speaking it may be stated that at a given setting of the aids, the aid giving rise to the smallest radius of curvature defines the chip form. In such a case the other aid may have a supporting task.

Tool 11, 11*a* is adjustable over path of adjustment 34 for removing chips having a thickness from zero to a maximum thickness 2. When traversing said path of adjustment 34, the centre of curvature of the removed chip shifts from point 7*b* along the line of displacement or locus 24 to point 7*c*. The path of adjustment 34 is so chosen that the gap width rapidly increases.

The path of adjustment 41 of the top iron is chosen for instance so that the free cutting face width 18*a*, 18 respectively, increases linearly with the chip thickness. When traversing said path of adjustment 41, the centre of curvature goes from point 7*d* — when the top iron is set against the sole plate edge, i.e. the zero position — towards point 7*e*, which corresponds with maximum chip thickness. Since, as indicated above, the smallest radius of curvature defines the path of the removed chip, the centre of curvature of the chip will traverse the path 7*b*—7—7*e* in the example shown, wherein tool and top iron respectively traverse the paths of adjustment 34 and 41 simultaneously, and wherein the respective lines of displacement intersect each other in point 7. It is mainly the front table edge that is operative over path 7*b*—7, while the top iron has a supporting function; the top iron is operative over the path 7—7*e*; and both are operative in point 7.

Whether there is a point of intersection 7 and if so, where this point is positioned precisely, depends on the chosen positioning of the top iron and the selected path of adjustment in combination with the rake angle of the cutting tool and the selected path of adjustment.

The mechanical coupling between top iron and cutting tool may be realized in various manners, so that the required path of displacement for the centre of curvature is followed at varying chip thickness. A tool which is constructed so that the method illustrated in Fig. 5 can be carried out therewith, is shown in section in Fig. 6. In the block plane shown, the sole plate comprises a front sole plate 22 and a back sole plate 40. The cutting tool 11 is clamped on the back plate 40 by means of a strap 41*a*. The back sole plate 40, which for instance is a triangular, bent sheet, rests against a rear block 45 which likewise may be such a bent sheet. The two are clamped against each other with superimposed sliding surfaces by means of pins 42 with retaining clips 43. Rear block 45 is fitted by means of pins or bolts between two side plates 52 extending over the entire length of the plane. Only one rear side plate is shown in the drawing. The back sole plate 40 is guided by the side plates.

The sliding surface between back sole plate 40 and rear block 45 has such an inclined position that the path of adjustment of tool 11 corresponds to the path of adjustment 34 shown in Fig. 5.

The setting is effected by means of a chip thickness setting bolt 50 which rotates in a lip of rear block 45, and which coacts via very fine threading, i.e. having a very small pitch, with a thickening on the back sole plate 40.

The adjustment to chip thickness may be read on the vernier scale 44. When determining the zero position, allowance is made for the spring-back of the wood. The zero position setting is effected by means of marks 6.

The front sole plate 22, which runs in two grooves in side plates 52, has an upturned lip 8 with which two adjustment bolts 56 cooperate.

A top iron 20 is attached to a tilting arm 48 by means of clamping bolts 51. Pivot pin 49 is supported in the side plates 52, e.g. in grooves perpendicular to the side plates.

When setting the chip thickness, the point of the top iron describes a circular path which corresponds to the path of adjustment 41 in Fig. 5. After the setting, the required clamping force of the top iron is obtained by securing clamping bolt 47. Since such a plane can be so easily set to different chip thicknesses, the use of more planes, for instance one for roughening and one for planing a thin chip, has become superfluous.

WHAT WE CLAIM IS:—

1. Apparatus for shaving wood comprising a non-rotary cutting tool and one or more aids namely a sole plate or pressure bar and/or a top iron coacting with the cutting tool to constrain the chip removed from the wood to follow a predetermined path, means for adjusting the depth of the cutting tool to remove chips of different thickness, and means for simultaneously adjusting the said relative to the tool so that upon adjustment of the cutting tool to remove a chip of desired thickness the aid is also adjusted so that the centre of curvature of the path traversed by the removed chip always lies on a line for causing an optimum rive crack as herein defined associated with the desired chip thickness.

2. Apparatus according to Claim 1, which includes a sole plate, and wherein the adjust-

ing means is arranged to move the cutting tool from a zero position in which no chip is removed and a position corresponding to the desired chip thickness so that the cutting edge of the tool traverses a path which lies in the acute angle between the downward prolongation of the bisector of the angle between the sole plate and the upper face of the cutting tool in the zero position and the sole plate, and so that the rake angle of the tool is maintained substantially constant, the rake angle being the angle between the upper face of the tool and a plane perpendicular to the sole plate through the cutting edge of the tool.

3. Apparatus according to Claim 2, wherein the sole plate comprises a front sole plate and a back sole plate, the cutting tool is mounted on the back sole plate and is adjusted therewith as a unit, and including a top iron abutting the upper face of the cutting tool at a substantially constant angle.

4. Apparatus according to Claim 3, wherein the back sole plate is slidable relative to a block fixedly connected to the front sole plate whereby the back sole plate is adjustable in a direction corresponding to the path of adjustment of the cutting tool, the top iron is mounted on an arm pivotally connected to the block by a pivot pin, and means are provided for clamping the top iron against the upper face of the cutting tool.

5. Apparatus according to Claim 4, wherein the pivot pin is so designed that, in the absence of clamping force, the arm is removable and remountable without disturbing the adjustment of the top iron relative to the cutting tool.

6. Apparatus according to Claim 4 or Claim 5, wherein the block and the back sole plate are provided with a vernier scale for indicating the depth to which the cutting tool is set.

7. Apparatus according to any one of Claims 4 to 6, wherein the back sole plate and the block are connected by one or more resilient retaining clips.

8. Apparatus for shaving wood as claimed in Claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

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1580220 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

FIG.1

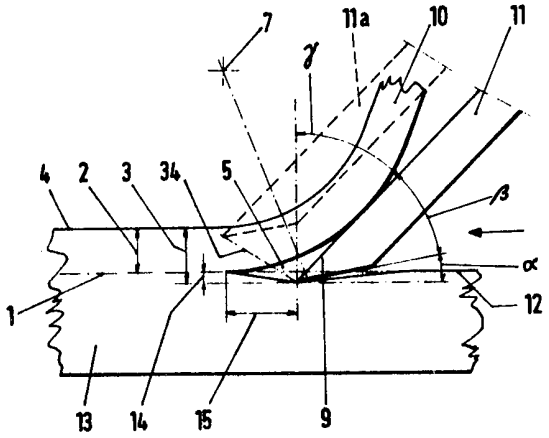


FIG.2

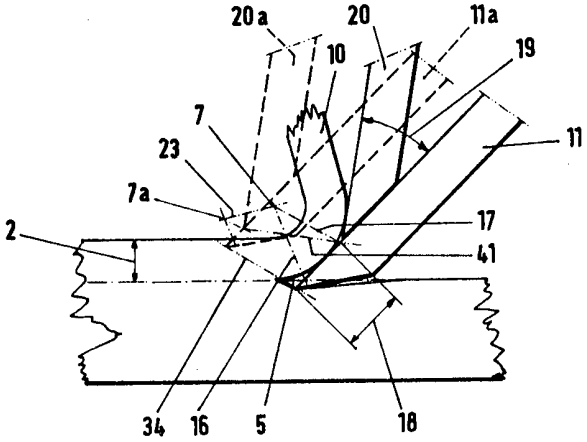


FIG. 3

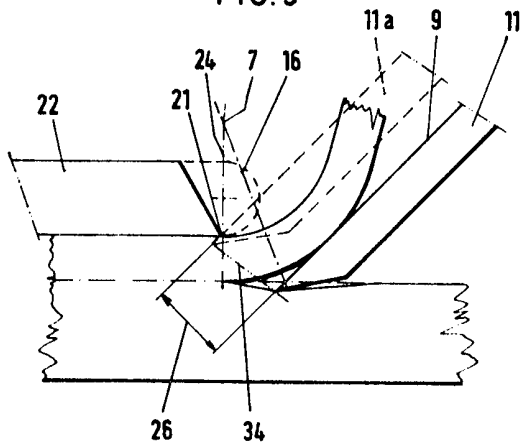


FIG. 4

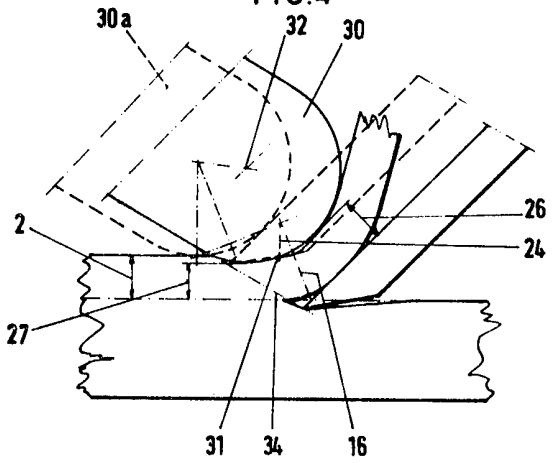
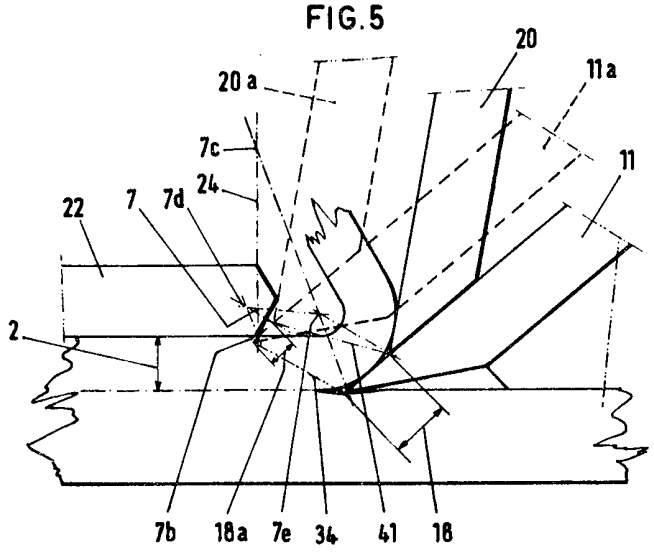


FIG.5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11a
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7c
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7d
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7b
18a
7e
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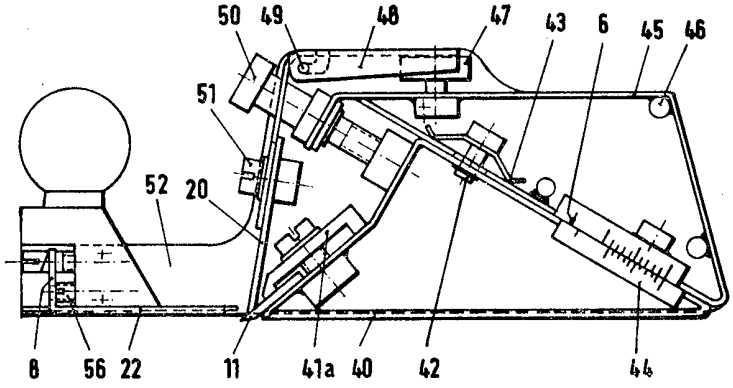
FIG.6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41a
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