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Patent Application

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ADJUSTABLE CUTTING TOOL HOLDER

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09/666,348 ALO	ADJUSTABLE CUTTING TOOL HOLDER	William Lee Steinhour, III Drew West Steve Honeycutt Steven Frank Kallutla Krishnamurthy	052-6008087 DE-AC04-76DP00613

DISCLAIMER

ADJUSTABLE CUTTING TOOL HOLDER

The United States Government has rights in this invention pursuant to a grant under Contract No. DE-AC04-76DP00613 between Honeywell Federal Manufacturing & Technology and the United States Department of Energy.

FIELD OF THE INVENTION

The invention relates to machining operations. More specifically, it relates to a device for varying the geometry of a cutting tool for use in machining operations.

Machining is a process in which unwanted material is removed from a workpiece in the form of chips. Turning is one chip-forming process. It involves rotating the workpiece and moving the cutting tool relative to the rotating part. The cutting point, i.e., the portion of the cutting tool in contact with the workpiece, may be formed by grinding on the end of the tool shank or may be provided by an insert that is clamped or brazed to the end of the shank.

One of the numerous factors that influence the productivity of machining operations is tool geometry. Thus, the cutting operation is affected by the orientation of the cutting tool relative to the workpiece. In particular, the top and side rake angles have a major effect on chip formation and that is the focus of the present invention. The new design disclosed herein provides a mechanism by which the rake angles can be changed independently to suit a particular machining environment.

There are at least two application areas where the present invention would be most beneficial: first, in a job shop environment where different materials are being machined and where batch sizes are small (the conditions here also resonate with those desired in an agile manufacturing system); second, in a development environment where the process parameters are being determined for new work materials and/or new tool materials. In both cases, the invention provides a quick, convenient, and economical means of changing the geometry of the cutting tool.

BACKGROUND OF THE INVENTION

As stated earlier, machining operations are used to obtain parts of desired shape and size by removing material from a workpiece. It is estimated that US industries spend over $50 billion each year to perform these operations which range from rough machining to precision machining where dimensional tolerance of 0.0001 inch is not uncommon. Due to economics, considerable research has been done to optimize the machining performance. However, solution to this problem is difficult because of the large number of factors that affect metal removal operations. Success depends on choosing the correct input parameters to the machine (viz., speed, feed, and depth of cut for a lathe) and the cutting tool (viz., material and geometry). The latter is the most critical factor and the present invention is devoted to adjusting the tool geometry. Specifically, adjustment to the side and top rakes are considered here.

The top and side rake angles are important as they determine the ability of the tool to shear the work material and form chips. The top rake angle usually controls the direction of chip flow and is of less importance than the side rake angle. A small rake angle results in high chip compression leading to large tool force and friction, while large rake angles reduce the chip compression, tool force, and friction. However, large angles also lead to reduced tool life due to reduced tool contact area. Positive rake angles are generally used on high-speed steel. On the other hand, zero or negative rake angles are used in machining hard work materials.

Typically, a handbook is consulted to determine the tool geometry once the tool material and work material are identified. The main disadvantage of existing tool holders is that they are not adjustable. In order to change the tool geometry, the entire tool holder must be moved by the application of metal shims or a different tool holder must be used. These methods may be imprecise, tedious, time-consuming, and expensive. However, a wide range of rake angles can be obtained with one unit using the invention described herein. In other words, the present invention obviates the need to use multiple tool holders and/or to recalibrate the cutting machine. Consequently, the desired angles can be obtained precisely, repeatedly, economically, and with minimal setup time.

THE PRIOR ART

A prior art tool holder is described in US Patent No. 5,159,863, issued on November 3, 1992 to V. E. Simpson. The invention is for cutting circular grooves having widely differing diameters in the end face of a workpiece. The tool holder design works by essentially varying the rake angles, although no such claim is made. In one embodiment, the side rake angle of the cutting insert can be adjusted. In an alternate embodiment, the top rake angle of the cutting insert can be adjusted. Still, there exists a substantial need in the art for an improved tool holder which would permit changing both side and top rakes angles independently and permit use in a wide range of machining operations such as turning, boring, and milling.

SUMMARY OF THE INVENTION

The present invention specifically addresses and alleviates the aforementioned deficiencies. It consists of an improved tool holder design to vary the cutting tool geometry (i.e., side and rake angles). Two nested partial cylinders are used to change the angles independently. Since the location of the cutting point must remain the same, the partial cylinders have their centers located at this point and their axes of rotation are aligned with and perpendicular to the axis of the main body of the tool holder.

In addition, the invention discloses a method which permits the tool holder to be set up accurately and rapidly in a typical manufacturing environment. Basically, this involves the use of locating holes in the partial cylinders together with a L- or T-pin. The design and method of use permit varying the rake angles without removing the tool holder from the machine support structure. This is crucial to maintain the accuracy requirements of most machining jobs.

These features will be more fully understood by reference to the following drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of the adjustable tool holder assembly.

Figure 2 is an exploded view of the adjustable tool holder assembly shown in Figure 1.

Figure 3 is a perspective view of the shank component.

Figure 4 is a rear view of the shank component.

Figure 5 is a perspective view of the side rake component.

Figure 6 is a rear view of the side rake component.

Figure 7 is a side view of the top rake component.

Figure 8 is a front view of the support arm component.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a perspective view of the complete adjustable tool holder assembly **1**. The side and rake angles can be varied independently and the tool holder is assumed to hold a cutting insert. Figure 2, an exploded view of the tool holder assembly, shows the four basic components **2** to **5**.

Shank component **2**, in Figure 3, is the main body of the tool holder with one end designed to fit into the mounting device, such as turret or tool post, in the cutting machine structure. The other end has a pocket **2a** which is an inward curved cylindrical segment having an axis through the cutting point and parallel to the axis of the main body. The pocket **2a** features a slot **19** which can also be seen in Figure 4. This slot extends through the pocket and has a counterbore on the back side. The pocket **2a** also features through holes **6** to **16** on either side of slot **19.** These holes are strategically located to obtain specific side rake angles. For example, holes **6** to **11** can provide for side rake angle settings of –10°, -5°, 0°, +5°, +10°, and +15°, and holes **12** to **16** can provide for –7.5°, -2.5°, +2.5°, +7.5°, and +12.5°.

The side rake component **3** is illustrated in Figures 2, 5, and 6. It resembles a quarter cylinder with the outward curved cylindrical segment **3a** having the same radius as that of pocket **2a**. The side rake component also features three holes **17**, **18**, and **22** on the curved segment **3a**. Hole **22** is threaded (not shown), while **17** and **18** are plain holes all extending for a short distance in **3**.

When component **3** is nested in pocket **2a**, the side rake component can rotate with respect to the main body of the tool holder. It is this rotation that offers the adjustment to the side rake angle on the cutting tool. Furthermore, upon nesting, slot **19** is aligned with hole **22** to removably secure the side rake component **3** with the shank component **2** by means of a screw **20** and a washer **21**. The screw **20** engages with the threads of hole **22**. Also, one of the holes **6** to **16** will align with either hole **17** or **18**. This latter feature allows the rapid adjustment of the side rake angle. Specifically, a L- or T-pin (not shown) could be used to align the hole which would yield the desired side rake angle from the set of holes **6** to **16** with either hole **17** or hole **18**, as the case may be. Then, screw **20** could be tightened to secure the side rake component **3** with the shank component **2**.

The side rake component **3** also features two pockets **3b** and **3c**. Pocket **3b** is an inward curved cylindrical segment having an axis through the cutting point and perpendicular to the axis of the main body. Pocket **3c** is rectangular in shape and is inclined at an angle from the vertical axis. With the pockets established, holes **32**, **33**, **39** and **42** can be defined. Holes **32** and **33** are plain holes, while holes **39** and **42** are threaded (not shown) but all extend a short distance in **3**.

The top rake component **4** is illustrated in Figures 2 and 7. Similar to **3**, this also resembles a quarter cylinder with the outward curved cylindrical segment **4a** having the same radius as that of pocket **3b**. The pocket **4b** accommodates a cutting insert (not shown). Nor is its attachment mechanism discussed here. The top rake component **4** also features a slot **38** which extends through the thickness and is along an arc whose center coincides with that of the outward curved cylindrical segment. Likewise, **23** to **31** are through holes along an arc. Similar to holes **6** to **16**, these holes are strategically located to obtain specific top rake angles. For example, holes **24** to **28** can provide for top rake angle settings of -10°, -5°, 0°, +5 °, and +10°, and holes **28** to **31** for -7.5, -2.5°, +2.5°, and +7.5°.

When component **4** is nested in pocket **3b**, the top rake component can rotate with respect to the main body of the tool holder. It is this rotation that offers the adjustment to the top rake angle of the cutting tool. Furthermore, upon nesting, slot **38** is aligned with hole **39** to removably secure the top rake component **4** with the side rake component **3** by means of screws **36** and **40** together with the support arm **5**. Screws **36** and **40** engage with the threads of holes **39** and **42**, respectively. Also, one of the holes **23** to **31** will align with either holes **34** and **32** or holes **35** and **33**. Again, this latter feature allows the rapid adjustment of the top rake angle. Specifically, a L- or T-pin (not shown) could be used to align the hole which would yield the desired top rake angle from the set of holes **23** to **31** with either holes **34** and **32** or holes **35** and **33**, as the case may be. Then, screws **36** and **40** could be tightened to secure the top rake component **4** with the side rake component **3**.

Component **5** is illustrated in Figure 8. The support arm is a flat piece with through holes **34, 35, 37**, and **41**. When nested in pocket **3c**, holes **37** and **41** align with holes **39** and **42,** respectively, and holes **34** and **35** align with holes **32** and **33**, respectively. The only purpose of support arm **5** is to support the head of the top rake bolt **36**, preventing extreme bolt deflection.

In use, the shank component **2** is clamped into the turret or tool post of the cutting machine structure. The top and side rake adjustments are made by first loosening screws **20, 36,** and **40**, and then aligning the alignment holes for the desired setting using a L- or T-pin. Screws **20, 36,** and **40** are then tightened to secure the settings and provide rigidity.

Although an embodiment of the present invention has been described in detail, it is to be understood that those knowledgeable in the relevant technical field will be able to make certain additions, deletions, or modifications without departing from the scope or spirit of the following claims. The function of the concept is not limited to the design shown, and should be interpreted in the illustrative and not the limited sense. For example, alignment could be accomplished by the application of splines. The rotation of the side and top rake components could be facilitated by using alignment pins as pivot points. The components could also be secured in a number of ways and the invention is not limited to the method shown here. The location holes could be labeled or different diameters could be used for identification purposes. Furthermore, the figures show a tool holder for use in turning operations. It can be modified for other machining operations.

ABSTRACT

The design of a tool holder that provides for the adjustment of side and top rake angles in material removal operations is presented. The shank (main component) of the tool holder is designed to fit into a mounting device, such as a turret or tool post, in the material removing machine structure. Two secondary components provide the adjustments for the rake angles. One of these components slides on a cylindrical surface machined in the shank component to provide for the adjustment of the side rake angle. Whereas, the other secondary component slides on a cylindrical surface machined in the side rake secondary component to provide for the adjustment of the top rake angle. A L- or T-pin together with holes drilled at selected locations in the main and secondary components provide a means of quickly and accurately changing the geometry of the cutting tool. The components are held together rigidly by machine screws.

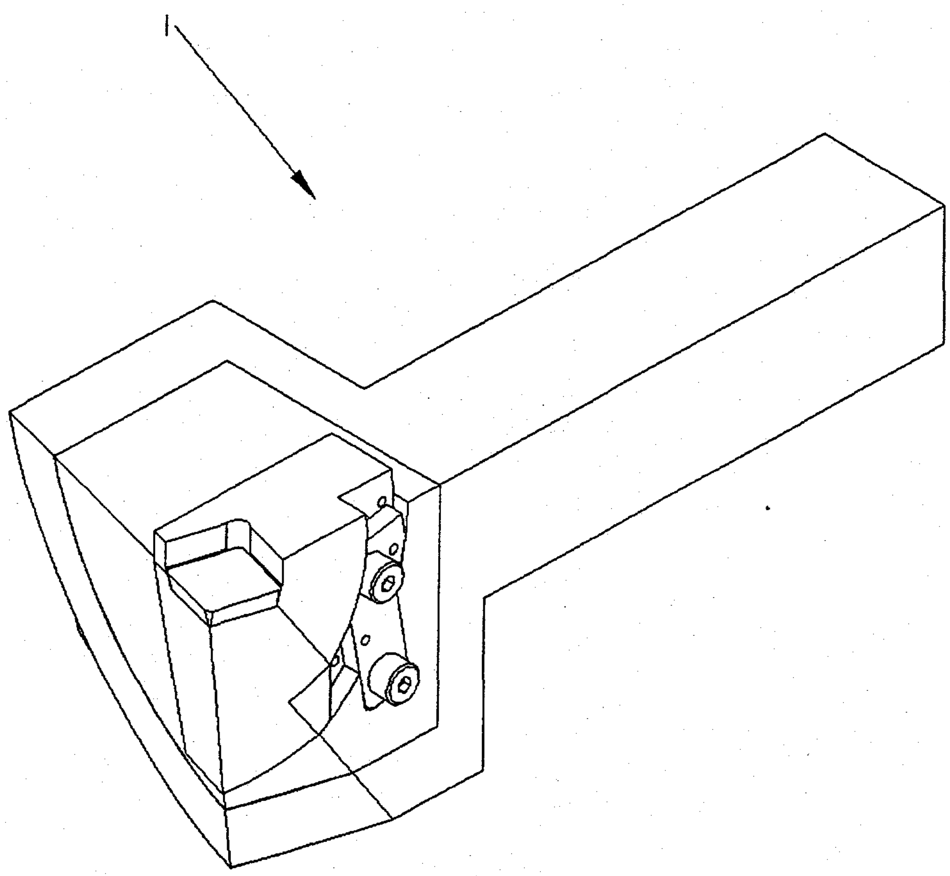

FIG. 1: Perspective View of the Adjustable Tool Holder Assembly

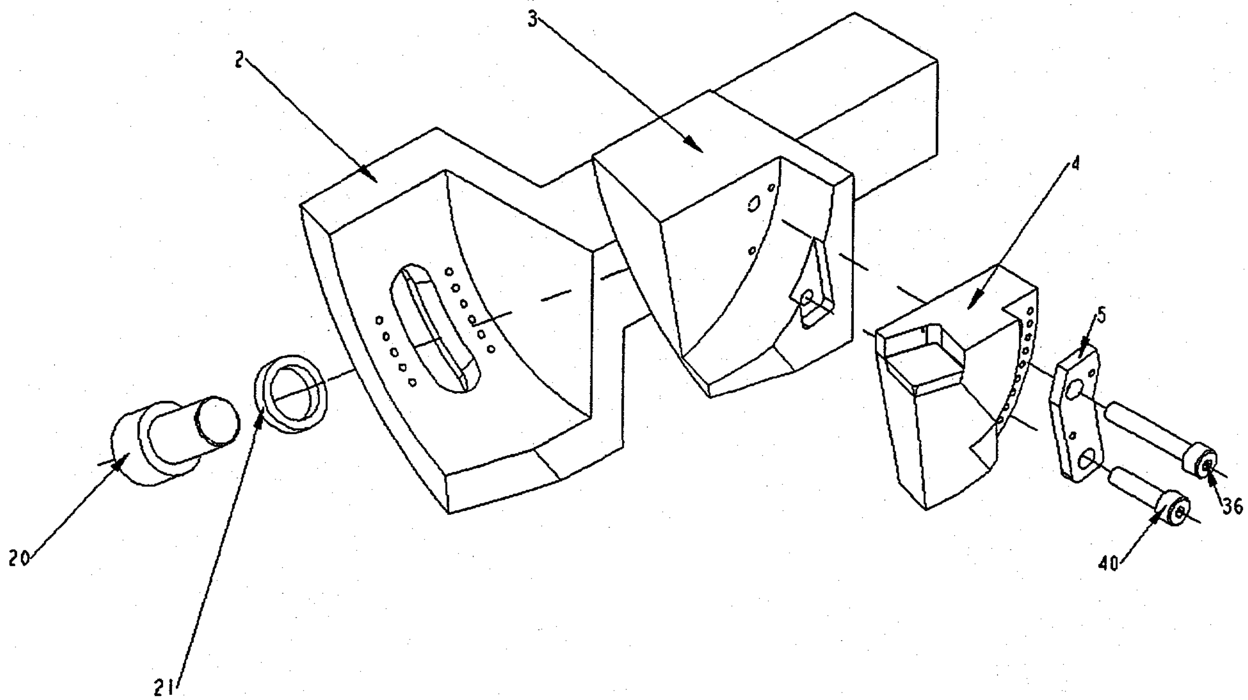

FIG. 2: Exploded View of the Adjustable Tool Holder Assembly of FIG. 1

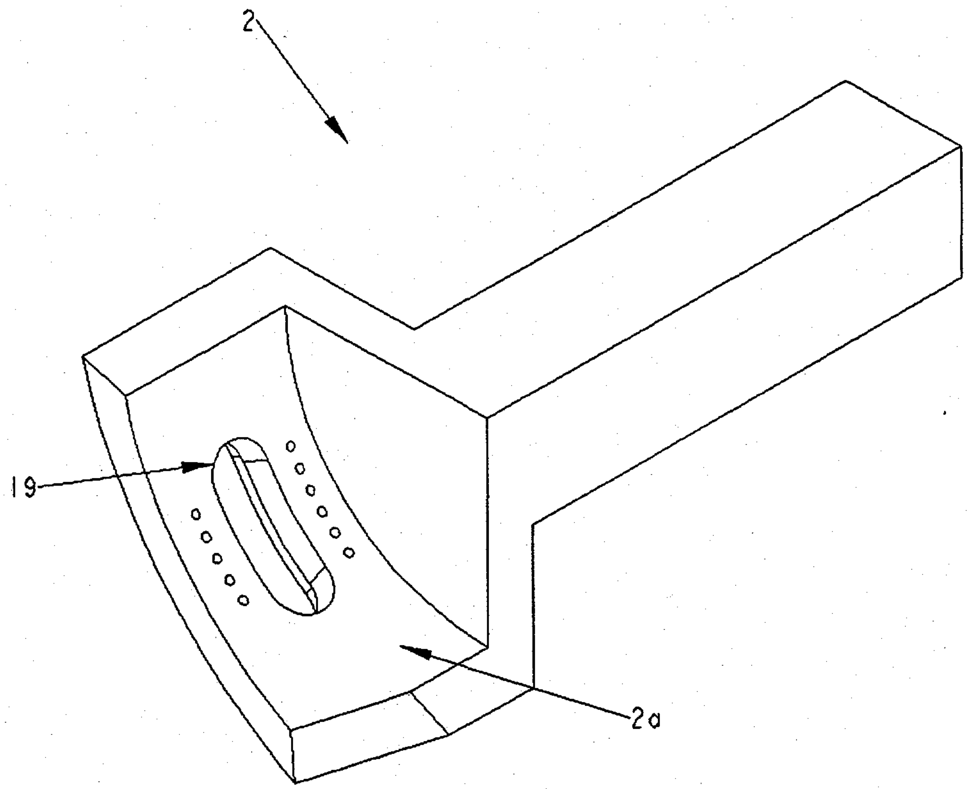

FIG. 3: Perspective View of the Shank Component

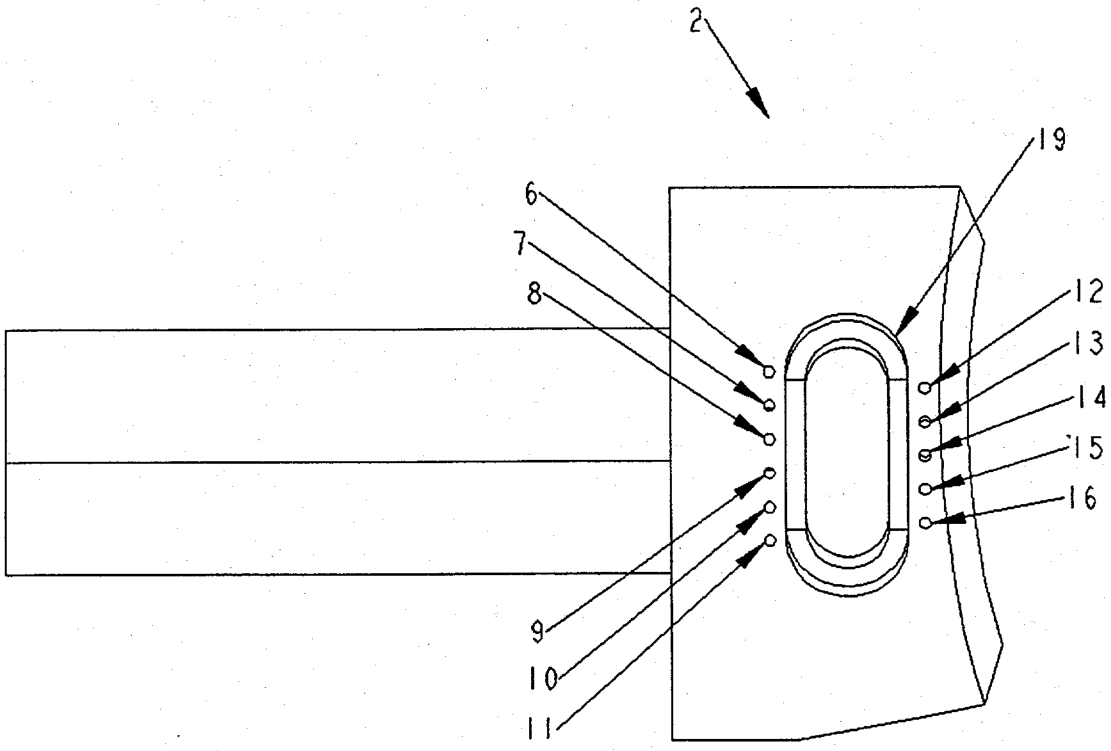

FIG. 4: Rear View of the Shank Component

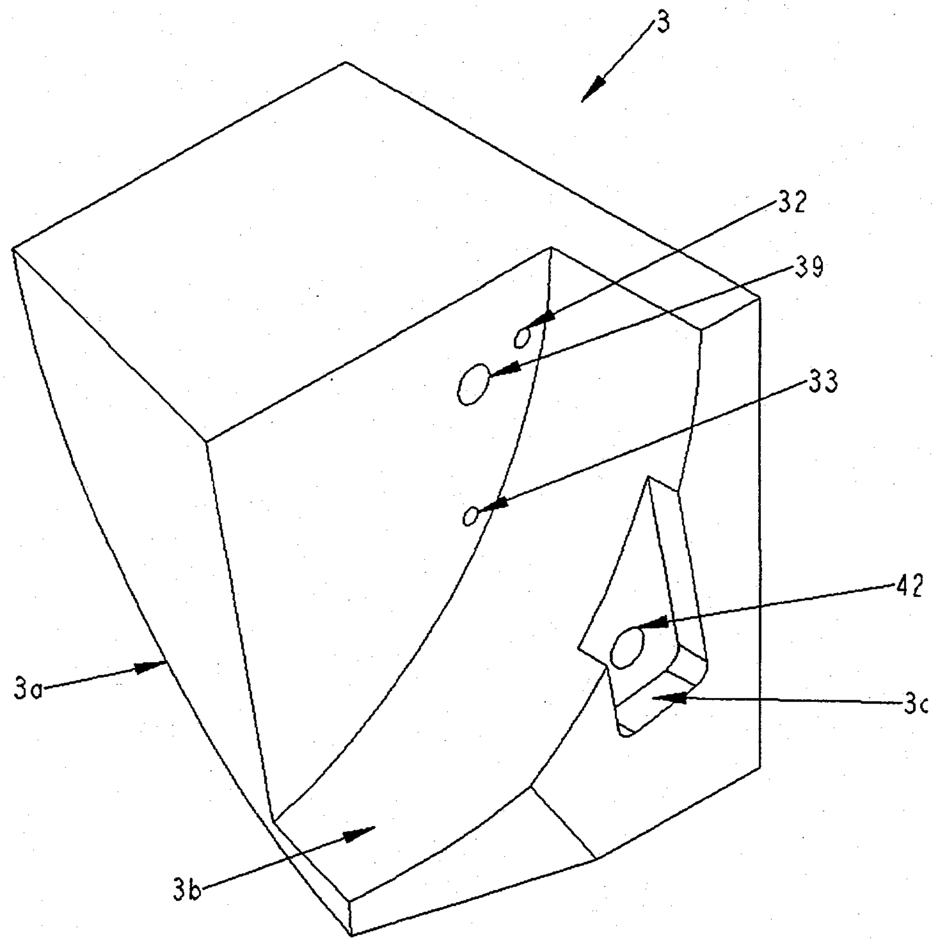

FIG. 5: Perspective View of the Side Rake Component

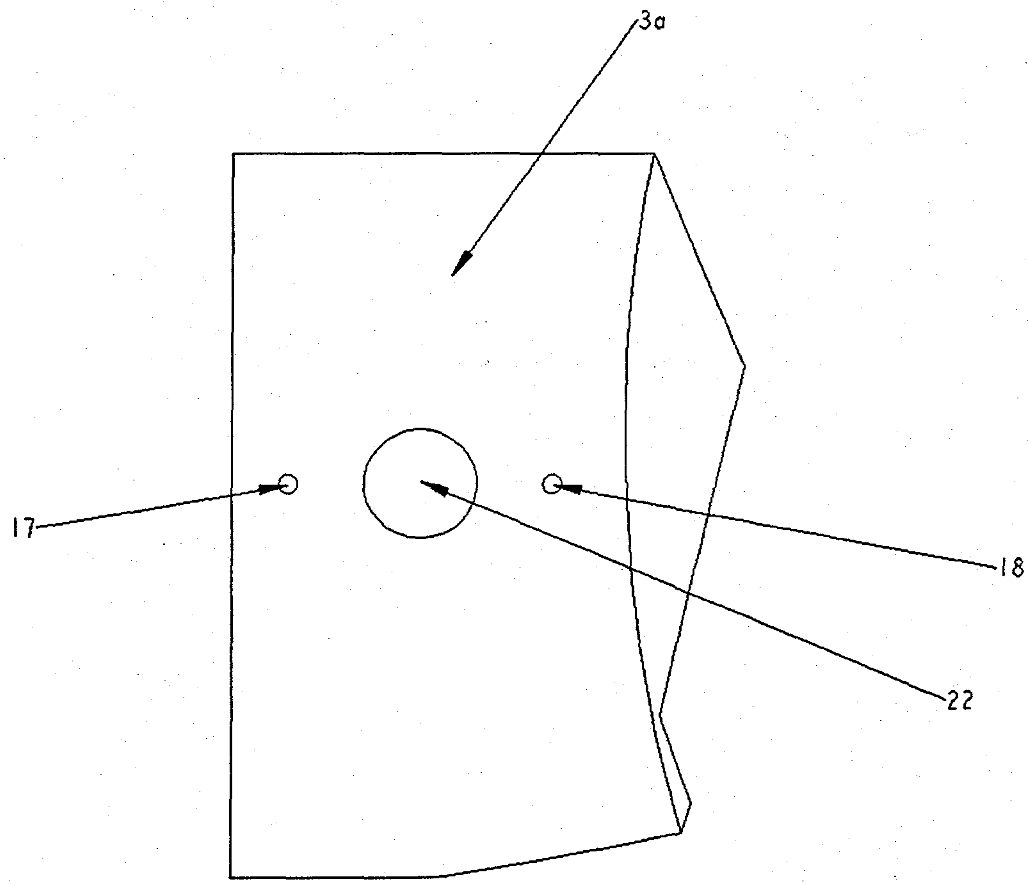

FIG. 6: Rear View of the Side Rake Component

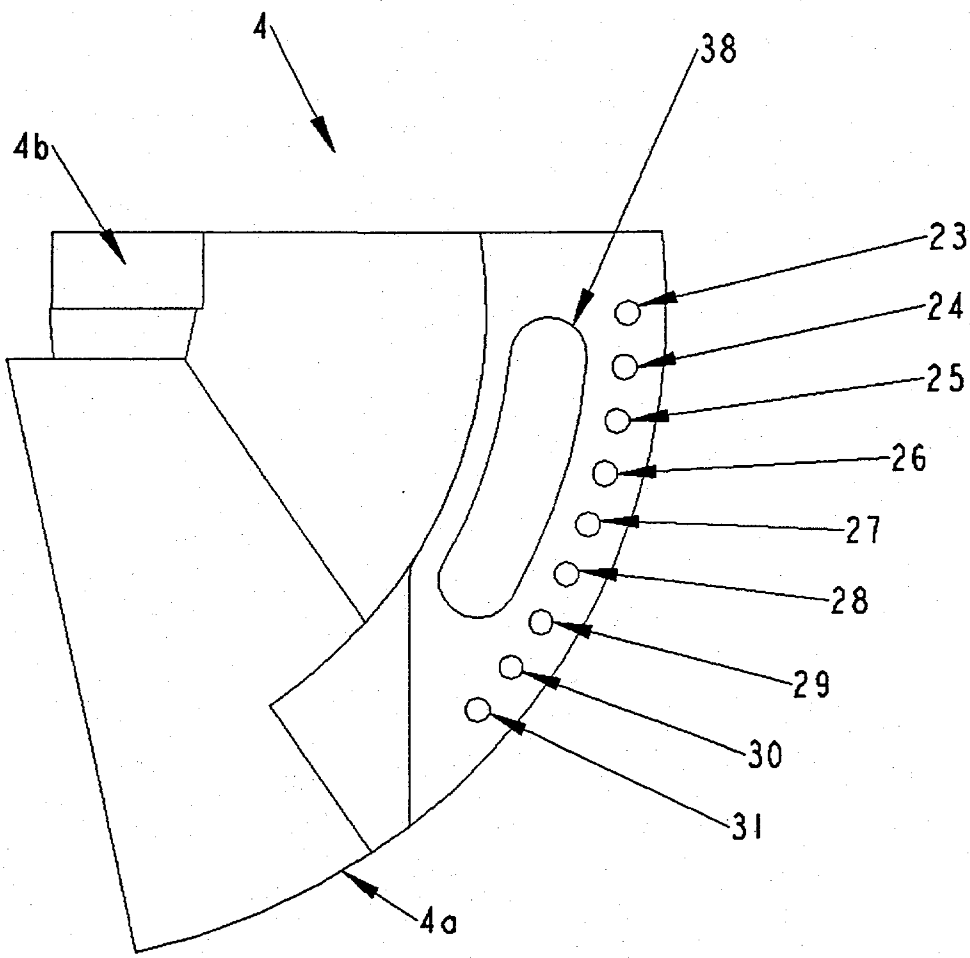

FIG. 7: Side View of the Top Rake Component

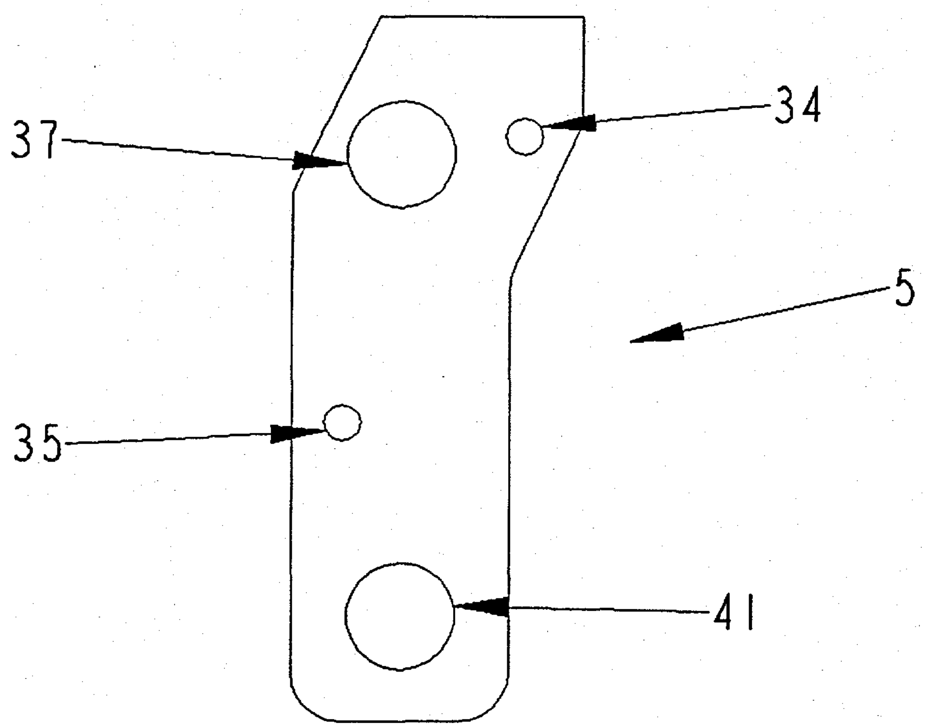

FIG. 8: Front View of the Support Arm Component