Articulated assembly of members.

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Description

This invention relates to an articulated assembly of members and in particular to articulated members incorporated in a machine tool for the presentation of a tool and a workpiece to each other with any desired relative angular disposition. The invention has particular, but not exclusive application in relation to a machine tool for the grinding or sharpening of the teeth of a circular saw blade.

Machine tools for the aforesaid purpose are known, i.e. tool and cutter, grinder, or a file sharpening machine, in which a workpiece and a grinding wheel are mounted in the machine tool at a desired relative angular disposition. Either one of the workpiece and grinding wheel, usually the latter, is then reciprocated relative to the other to effect the grinding of a tooth. When such grinding is completed the workpiece is processed by one tooth pitch so that the next tooth can be ground.

This operation having a time consuming one and readily leads to inaccurate grinding of the teeth as the method of indexing is usually manual.

To facilitate such an operation articulated assemblies of members are known such as that described in U.S.—A—3168003. Such an assembly comprises four members, the second, third and fourth members being mounted on the first, second and third members respectively so as to rotate relative thereto about a respective axis. The second axis is inclined relative to both the first and third axes at 45°, so that a considerable range of angular disposition of a workpiece mounted on the fourth member can be achieved. However rotation of the members relative to each other cause bodily displacement of the workpiece as well as a change of orientation, and for subsequent operations on a workpiece it may often be necessary to re-position the workpiece on the fourth member. In consequence inaccuracies of machining of a workpiece can arise.

It is an object of the present invention to provide an assembly of members, for example in a machine tool, in which the aforementioned disadvantage is avoided or at least substantially reduced.

The invention provides an articulated assembly of members comprising a first member, a second member mounted thereon for rotation relative thereto about a first axis, a third member mounted on the second member for rotation relative thereto about a second axis inclined relative to the first axis, and a fourth member mounted on said third member for rotation relative thereto about a third axis inclined relative to said second axis, said fourth member having means for mounting a tool or workpiece thereon, wherein said second axis is inclined at substantially 45° relative to said first axis and to said third axis, characterised in that said three axes intersect at a common point fixed relative to said first member throughout the range of relative angular movement of said members, said common point lying outside said fourth member adjacent to and spaced from said outer surface thereof.

The invention also provides a machine tool for operating on a workpiece comprising a tool holding means, and workpiece support one of which includes said assembly of members.

A preferred embodiment of the machine tool may comprise means for positionally adjusting at least one of said tool holding means and said workpiece support linearly relative to the other.

Drive means may be provided for effecting the relative rotary movement of said parts relative to each other, and for adjusting the relative positional movement of said tool holding means and said workpiece support relative to each other. Control means may be provided and be operable to control such drive means.

A machine tool equipped with such an articulated assembly of members may comprise means operable to effect reciprocating motion of said workpiece support which may be mounted in said machine tool so as to be reciprocable towards and away from said tool holding means to facilitate the effecting of said operation. The workpiece support may be mounted on guides of a table of said machine tool. The machine tool may comprise drive means operable so that said tool holding means may be driven in rotation also to facilitate effecting said operation. The machine tool may also comprise a tool in the form of a grinding wheel.

Apparatus in accordance with the invention will now be described with reference to the accompanying drawings in which:

Figs. 1 to 3 are respectively a front elevation, a side elevation and a plan of one embodiment, and
Figs. 4 to 6 are respectively a sectional side elevation, an end elevation and a plan of the articulated assembly of Figs. 1 to 3.

Referring now to Figs. 1 to 3, there is shown a machine tool T for the grinding or sharpening of the teeth of a circular saw blade 2. The saw blade 2 is secured to a workpiece support 3 which is mounted on guides 4a of a table 4 of the machine tool T. Disposed above the table 4 is a tool holding means comprising an upstanding pillar 9, an extension arm 7 which is secured to pillar 9 by a bracket 8, and a spindle support bracket 6 mounted at the free arm of 7. Mounted for rotation within the spindle support bracket 6 is a spindle 6a on which a grinding disc 1 is mounted.

Pillar 9 is movable vertically relative to table 4 and arm 7 is movable horizontally relative to pillar 9, as shown by arrows A and B respectively. In addition either pillar 9 may be rotated about its longitudinal axis relative to table 4, or clamp 8 may be rotated on pillar 9 about that axis. In consequence there is complete freedom of movement for the positional adjustment of saw blade 2 relative to the grinding wheel 1.

The spindle 6a and the grinding wheel 1 are rotatably driven by conventional motor drive means (not shown), and a guard 5 encloses a substantial part of the grinding wheel 1 for safety purposes.
The workpiece support 3 comprises a first part 3a which is slideable in guides 4a as referred to above. On part 3a is a frusto-cylindrical second part 3b which can rotate on part 3a about a vertical first axis A1. A frusto-cylindrical third part 3c is mounted on part 3b so as to be rotatable about a second axis A2 and a fourth part 3d, to which the workpiece 2 is secured, is mounted on part 3c so as to be rotatable about a third axis A3. Second axis A2 is inclined at 45° to axes A1 and A3 so that the latter may be coincident or relatively inclined by up to 90° as desired. By virtue of the relative movements of parts 3b and 3c relative to part 3a the saw blade 2 can be presented to the grinding wheel 1 at any angular disposition required, this may be facilitated by indexing means 11 and such indexing means may be manually operable or controlled by control means (not shown).

With the saw blade 2 at the desired angular disposition and the rotating grinding wheel 1 correctly positioned relative to the saw blade 2, the saw blade 2 may be reciprocated past the grinding wheel 2 by means of a motor (not shown) driving, via a gearbox 10, the workpiece support 3 along the guides 4a. In this way a grinding pass is made. When the grinding of a tooth has been effected the saw blade 2, and part 3d to which it is secured, are then rotated about axis A3 by an angular amount equal to the angular pitch of the teeth of blade 2 so that the operation can be repeated on the next successive tooth.

When all of the teeth of blade 2 have been ground at one face of blade 2 the angular disposition of parts 3b and 3c relative to parts 3a and 3b respectively may be equal but opposite, relative to a datum position, to those previously set. The blade is then turned over and positionally reset, and the grinding wheel is reset, so that the blade and grinding wheel are again at the required relative angular disposition for the grinding of the other face of each tooth to be performed. The procedure is then repeated for the opposite face of saw blade 2. However, a machine tool comprising such an articulated assembly of members has particular applicability to the grinding of reverse form toothed blades such as are used for the manufacture of paper tubes and boards, in which case the direction of indexing of the saw blade is reversed for the grinding of the teeth on the opposite face of saw blade 2.

By means of the arrangement herein disclosed the grinding of new teeth or the sharpening of existing teeth may be readily accomplished in a simple, quick and accurate manner.

It has been found that, by means of such an arrangement, a workpiece (or machine tool) can be offered to a machine tool (or workpiece) in like manner and disposition at any angle or location on or inside the hemisphere described by its rotation about its base's centre, thus allowing of sequential operation on a workpiece by automatic equipment having a multiplicity of machine tools operatively carried thereby.

Referring now to Figs. 4 and 6 there is shown an articulated assembly of members 40 which may for example be a workpiece support in a machine tool. The assembly 40 comprises members 41, 42, 43 and 44. First member 41 is a base which may be secured to a table (not shown) of the machine tool. Second or stand member 42 is mounted on base member 41 for rotation about a first axis 45. A third or top member 43 is mounted on stand member 42 for rotation about a second axis 46 which is inclined at 45° to first axis 45. A fourth or table member 44 is mounted on top member 43 for rotation about a third axis 47 which is inclined at 45° to a second axis 48. The three axes 45, 46, 47 are coincident at a point 48 which lies above the outer surface 49 of table member 44, to provide a datum point for a workpiece (not shown) secured to the table member 44 for subsequent machining at any orientation.

In the configuration shown, axes 45 and 47 are coincident. If the top member 43 is rotated about axis 46 relative to stand member 42, the table member 44 will likewise move about axis 46 but the centre of the workpiece will remain at or adjacent point 48. When 180° of such movement has occurred the surface 49 will be vertical and axis 47 will be horizontal at the centre of the workpiece will still remain at or adjacent the point 48, as shown by the chain-dotted lines in Fig. 4.

Such an arrangement will have particular application in cases where the orientation of a workpiece attached to table member 44 is to be changed with little or no displacement thereof.

Rotation of members 42, 43 and 44 about axes 45, 46 and 47 may be effected by respective motor driven shafts 50, 51, 52 via respective worms 53, 54, 55 and wheels 56, 57, 58 and the motors (not shown) of such motor drives may be microprocessor or computer controlled. Alternatively the rotations may be effected manually for example by hand wheels attached to shafts 50, 51 and 52 and indexing means (not shown) may be provided for facilitating accurate rotation of the relevant member to the desired angular disposition relative to the base member 41.

Although in the embodiment illustrated, all of the rotational axes lie in a common plane, two being coincident and the intermediate axis being inclined at 45° to such coincident axes, in other arrangements alternative dispositions may be provided.

It is not required, however, that all of the axes lie in a single plane, another useful configuration being one in which two of the axes lie in a given plane at 45° to each other whilst the third axis is likewise inclined at 45° relative to the first axis but is rotated about such first axis through 90° from the common plane of the first and second such axes.

For the purpose of supplying electrical power to stepper motors for rotating the shafts 50, 51, 52 and the spindles of the members 42, 43, 44 are hollow and accommodate rotary electrical connections (not shown) disposed on the axes 45, 46, 47.

The invention provides that a tool, which may
be for example a cutting device, drill or welding device, may require only a simple forward and reverse motion in order to operate on a workpiece at more than one location since the workpiece itself may be moved to the required orientations for receipt of the tool. This can obviate the need for computer controlled tool manipulators and thereby save cost of a machine installation. The principal advantage of the present invention lies in that the workpiece can be correctly positioned in both location and orientation senses, with very simple programming of the workpiece holding device, so that the tool can always operate in a single direction as mentioned above. The programming of a tool to operate in required location and orientation senses on a fixed workpiece is very complicated and expensive and this is obviated by the present invention.

A further advantage of the invention lies in having the point of concurrency of the three axes above the worktable surface. This enables the workpiece to be rotated relative to a tool for operation on up to 5 sides of a cube for severing the workpiece on a datum plane parallel with the work table or base surface of the workpiece, or even generation of a spherical object.

The invention also has application in flexible manufacturing wherein the workpiece holding device is palletised and mounted on a conveyor system. The workpiece can then be conveyed through a plurality of work stations in each of which some machining operation is performed thereon, the device being programmed to orient the workpiece as required at each work station to receive the respective tool at the station. Each tool at each work station thereby is only required to make a simple forward and reverse motion instead of a complicated, programmed movement, thus saving on the overall cost of the installation and manufacturing process.

In various forms of machining, and welding in particular, it is advantageous that a workpiece having angled faces can be orientated so that any particular face can be horizontal or vertical as desired for the machining or welding operation.

Claims

1. An articulated assembly of members (40) comprising a first member (3a, 41) a second member (3b, 42) mounted thereon for rotation relative thereto about a first axis (A1, 45), a third member (3c, 43) mounted on the second member for rotation relative thereto about a second axis (A2, 46) inclined relative to the first axis, and a fourth member (3d, 44) mounted on said third member for rotation relative thereto about a third axis (A3, 47) inclined relative to said second axis, said fourth member having an outer surface (49) with means for mounting a tool or workpiece thereon, wherein said second axis (46) is inclined at substantially 45° relative to said first axis (45), and to said third axis (47), characterised in that said axes (45, 46, 47) intersect at a common point (48) throughout the range of relative angular movement of said members (41, 42, 43, 44), said common point (48) lying outside said fourth member (44) adjacent to and spaced from said outer surface (49) thereof.

2. A machine tool for operating on a workpiece comprising a tool holding means (7, 8, 9) and a workpiece support (3) one of which includes an articulated assembly of members (40) comprising a first member (3a, 41), a second member (3b, 42) mounted thereon for rotation relative thereto about a first axis (A1, 45), a third member (3c, 43) mounted on the second member for rotation relative thereto about a second axis (A2, 46) inclined relative to the first axis, and a fourth member (3d, 44) mounted on said third member for rotation relative thereto about a third axis (A3, 47) inclined relative to said second axis, said fourth member having an outer surface (49) with means for mounting a tool or workpiece thereon, wherein said second axis (46) is inclined at substantially 45° relative to said first axis (45), and to said third axis (47), characterised in that said axes (45, 46, 47) intersect at a common point (48) throughout the range of relative angular movement of said members (41, 42, 43, 44) adjacent to and spaced from said outer surface (49) thereof.

3. A machine tool according to claim 2, characterised in that means (4a) are provided for positionally adjusting one of said tool holding means (7, 8, 9) and said workpiece support (3) linearly to the other.

4. A machine tool according to claim 3, characterised in that said position adjusting means (4a) comprises a table (4) having guides (4a) thereon on which said workpiece support (3) is slidingly mounted.

5. A machine tool according to claim 3 or claim 4, characterised in that drive means (6a) are provided operable to drive in rotation a tool (1) held in said tool holding means (7, 8, 9).

Patentansprüche

1. Gelenkige Anordnung von Bauteilen (40) mit einem ersten Bauteil (3a, 41), einem zweiten, an dem ersten Bauteil angebrachten Bauteil (3b, 42), das in bezug auf das erste Bauteil eine Erste Achse (A1, 45) rotiert, einem dritten, an dem zweiten Bauteil angebrachten Bauteil (3c, 43), das in bezug auf das zweite Bauteil eine zweite Achse (A2, 46) rotiert, und mit einem vierten, an dem dritten Bauteil angebrachten Bauteil (3d, 44), das relativ zum dritten Bauteil eine dritte, gegenüber der zweiten Achse geneigte Achse (A3, 47) rotiert, wobei das vierte Bauteil eine Außenfläche (49) mit Mitteln zur Befestigung eines Werkzeugs oder eines Werkstückes aufweist, und wobei die zweite Achse (46) in bezug auf die erste und die dritte Achse (45 und 47) um etwa 45° geneigt ist, dadurch gekennzeichnet, daß die drei Achsen (45, 46, 47) einander im genannten Bereich einer relativen Winkelbewegung der Bauteile (41, 42, 43, 44) in einem gemeinsamen Punkt (48) schnei-
den, der relativ zu dem ersten Bauteil (41) feststeht und außerhalb des vierten Bauteiles (44) nahe der genannten Außenfläche (49) und mit Abstand von ihr liegt.

2. Maschinenwerkzeug zur Bearbeitung eines Werkstückes, mit einem Werkzeughalter (7, 8, 9) und einem Werkstück-Support (3), von denen einer eine gle nkige Anordnung von Bauteilen (40) aufweist, die ein erstes Bauteil (3a, 41) umfaßt, an dem ein zweites Bauteil (3b, 42) angebracht ist, das in bezug auf das erste Bauteil um eine erste Achse (A1, 45) rotiert, und mit einem dritten, an dem zweiten Bauteil angebrachten Bauteil (3c, 43), das in bezug auf das zweite Bauteil um eine zweite Achse (A2, 46) rotiert, die gegenüber der ersten Achse geneigt ist, und mit einem vierten, an dem dritten Bauteil angebrachten Bauteil (3d, 44), das in bezug auf das dritte Bauteil um eine dritte Achse (A3, 44) rotiert, die gegenüber der zweiten Achse geneigt ist, wobei das vierte Bauteil eine Außenfläche (49) mit Mitteln zur Befestigung eines Werkzeugs oder eines Werkstückes aufliegt, und wobei die zweite Achse (46) um etwa 45° zu der ersten und zu der dritten Achse (45 und 47) geneigt ist, dadurch gekennzeichnet, daß die drei Achsen (45, 46, 47) einander im genannten Bereich einer relativen Winkelbewegung der Bauteile (41, 42, 43, 44) in einem gemeinsamen Punkt (48) schneiden, der außerhalb des vierten Bauteiles (44) nahe der genannten Außenfläche (49) und mit Abstand von ihr liegt.

3. Maschinenwerkzeug nach Abspruch 2, dadurch gekennzeichnet, daß Mittel (4a) zur Positionierung eines der Werkzeughalter (7, 8, 9) und des Werkstück-Supportes (3) linear zu dem anderen vorgesehen sind.

4. Maschinenwerkzeug nach Anspruch 3, dadurch gekennzeichnet, daß die Positionierungs-Mittel (4a) einen Tisch (4) mit zwei Führungen (4a) aufweisen, auf denen der Werkstück-Support (3) gleitend angeordnet ist.

5. Maschinenwerkzeug nach Anspruch 3 oder 4, dadurch gekennzeichnet, daß Antriebsmittel (6a) für den rotierenden Antrieb eines Werkzeuges (1) vorgesehen sind, das sich in dem Werkzeughalter (7, 8, 9) befindet.

Revendications

1. Assemblage articulé d'éléments de construction (40) comprenant un premier élément (3a, 41), un deuxième élément (3b, 42) monté sur celui-ci de manière à tourner par rapport à celui-ci autour d'un premier axe (A1, 45), un troisième élément (3c, 43) monté sur le second élément de manière à tourner par rapport à celui-ci autour d'un second axe (A2, 46) incliné par rapport au premier axe, et un quatrième élément (3d, 44) monté sur le troisième élément de manière à tourner par rapport à celui-ci autour d'un troisième axe (A3, 47) incliné par rapport au second axe, le quatrième élément possédant une surface extérieure (49) comportant des moyens pour monter un outil ou une pièce à usiner sur celle-ci, dans lequel le second axe (46) est incliné à peu près à 45° par rapport au premier axe (45), et au troisième axe (47), caractérisé en ce que les trois axes (45, 46, 47) se coupent en un point commun (48) fixé par rapport au premier élément pour toute la gamme de mouvement angulaire relatif des éléments (41, 42, 43, 44), le point commun (48) étant situé à l'extérieur du quatrième élément (44) au voisinage et écarté de la surface extérieure (49) de celui-ci.

2. Machine à outil pour réaliser une pièce comportant des moyens support d'outil (7, 8, 9) et un support de pièce (3) dont l'un deux comporte un assemblage articulé d'éléments de construction (40), comportant un premier organe (3a, 41), un second organe (3b, 42) monté sur celui-ci de manière à tourner par rapport à celui-ci autour d'un premier axe (A1, 45), un troisième élément (3c, 43) monté sur le second élément de manière à tourner par rapport à celui-ci autour d'un second axe (A2, 46) incliné par rapport au premier axe, et un quatrième élément (3d, 44) monté sur le troisième élément de manière à tourner par rapport à celui-ci autour d'un troisième axe (A3, 47) incliné par rapport au second axe, le quatrième élément possédant une surface extérieure (49) comportant des moyens pour monter un outil ou une pièce à usiner sur celui-ci, dans lequel le second axe (46) est incliné à peu près à 45° par rapport au premier axe (45), et au troisième axe (47), caractérisé en ce que les trois axes (45, 46, 47) se coupent en un point commun (48) fixé par rapport au premier élément pour toute la gamme de mouvement angulaire relatif des éléments (41, 42, 43, 44), le point commun (48) étant situé à l'extérieur du quatrième élément (44) au voisinage et écarté de la surface extérieure (49) de celui-ci.

3. Machine à outil selon la revendication 2, caractérisée en ce que des moyens (4a) sont prévus pour ajuster en position l'un des moyens support d'outil (7, 8, 9) et du support de pièce (3) de manière linéaire par rapport à l'autre.

4. Machine à outil selon la revendication 3, caractérisée en ce que les moyens (4a) pour ajuster en position comportent une table (4) possédant des guides (4a) sur celle-ci et sur lesquels le support de pièce (3) est monté coulissant.

5. Machine à outil selon la revendication 3 ou 4, caractérisée en ce que des moyens d'entraînement (6a) sont prévus de manière à entraîner en rotation un outil (1) maintenu dans les moyens support d'outil (7, 8, 9).