United States Patent

Stade

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[54] **METHOD OF AND APPARATUS FOR SHAPING THE PROFILED SURFACE OF A ROTATING TOOL FOR PRODUCING CYCLOID THREAD FLANKS ON SCREWS**

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[52] **U.S. Cl.**..**125/11,** 51/288

[51] **Int. Cl.**...**B24b 53/06**

[58] **Field of Search**......................................125/11; 51/288

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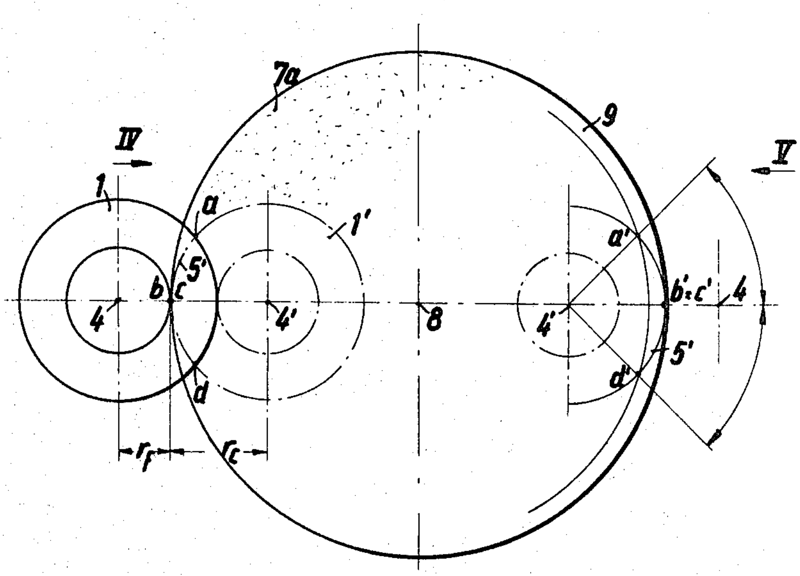
[57] **ABSTRACT**

A profiled surface of a rotating tool, such as a grinding disk, for producing cycloid thread flanks in screws, is shaped by a dressing device positionable in engagement with the surface of the disk which forms the threads. The dressing device is movable along a generated screw line determined as a helical line of contact between the screw being produced and an imaginary counter-screw in engagement with the screw. The dressing device includes a traverse bar on which diamond dressing points are positioned and the traverse bar is mounted for selectively moving the dressing point along the generated screw line in contact with the profiled surface of the disk so that the proper profile for forming cycloid thread flanks is obtained.

12 Claims, 11 Drawing Figures



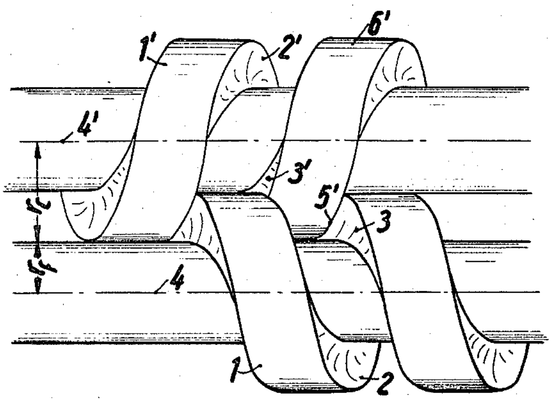


Fig. 1

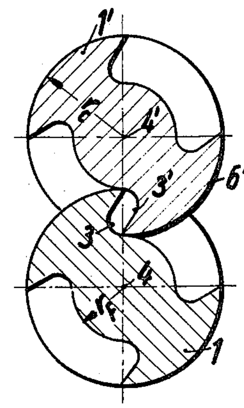


Fig. 2

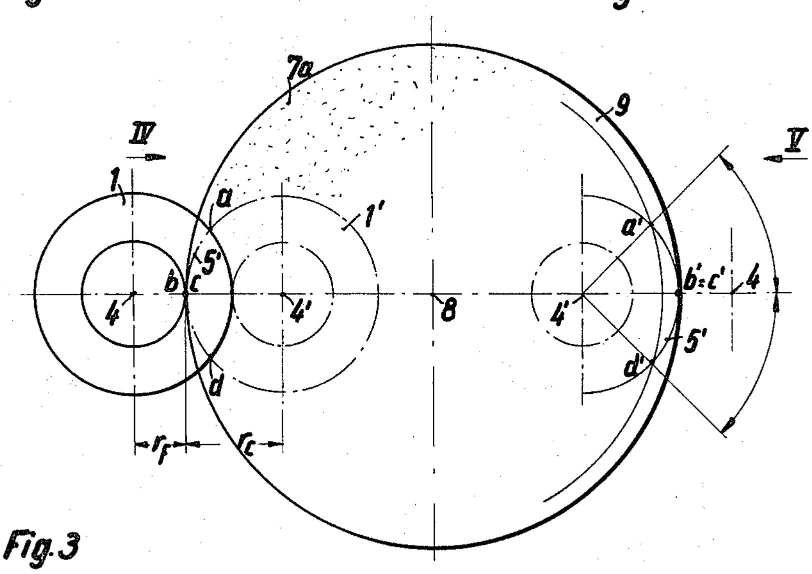


Fig. 3

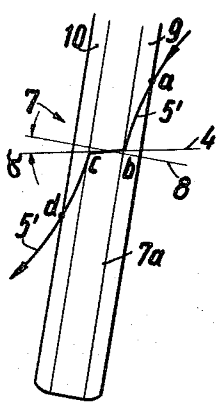


Fig. 4

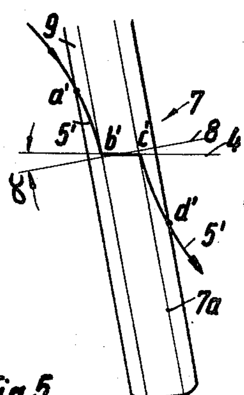


Fig. 5

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Fig.6

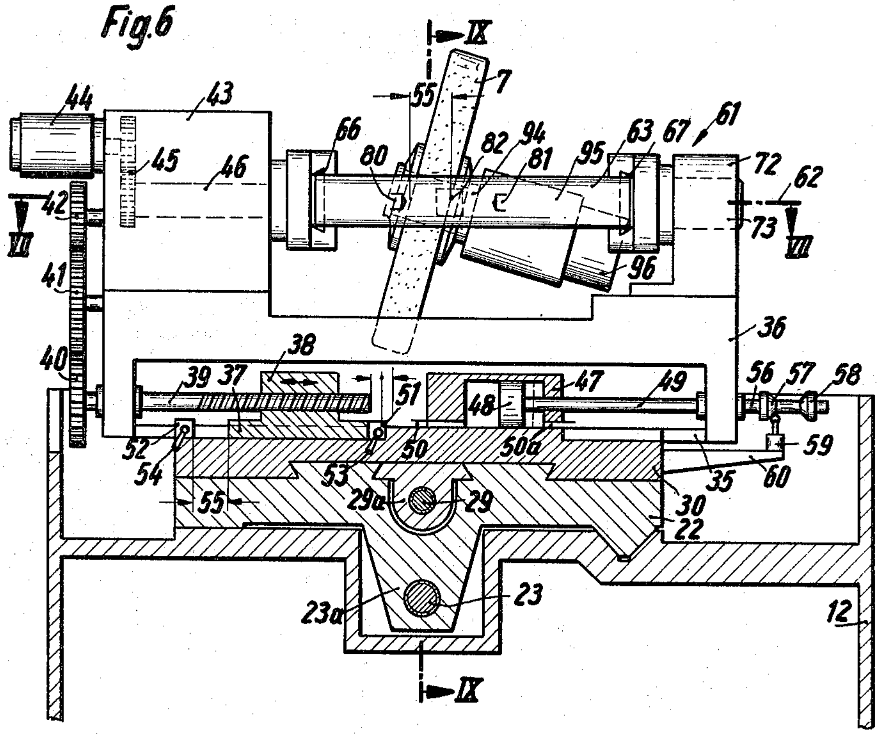

Fig.7

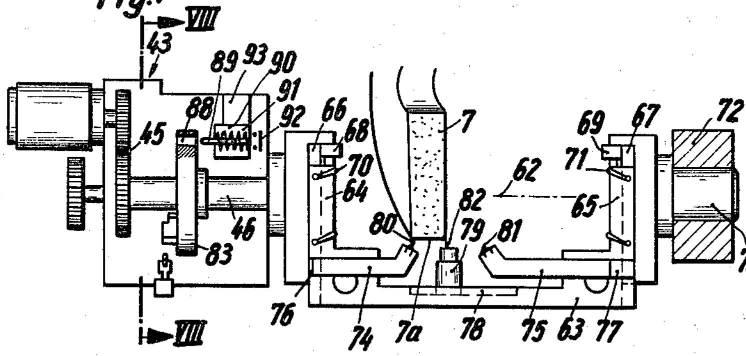

Fig.8

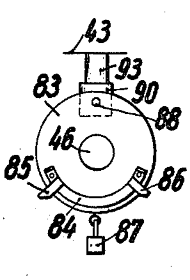

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Fig. 9

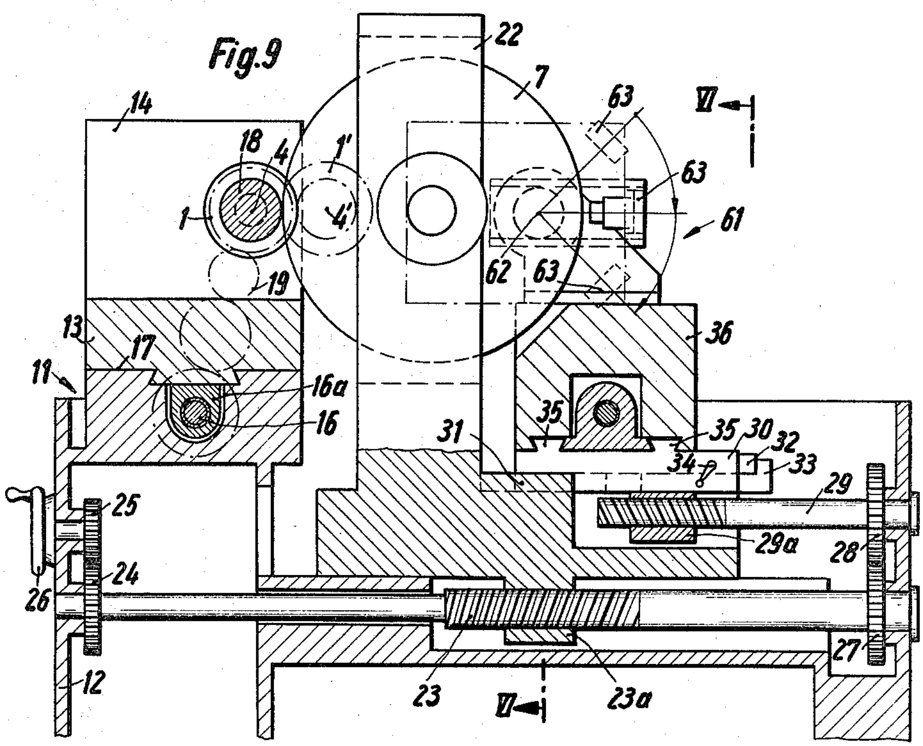
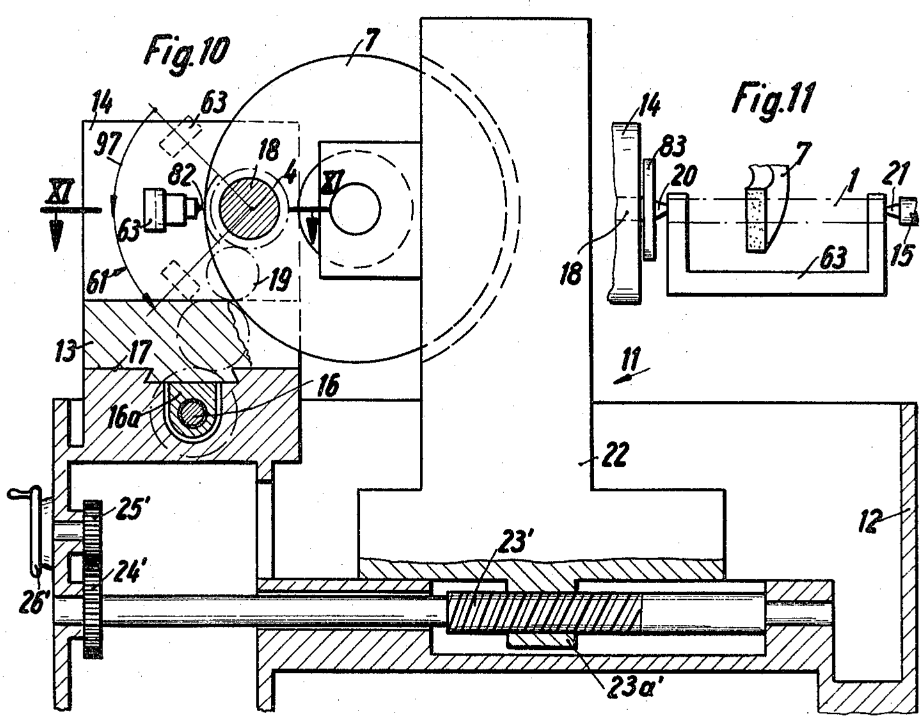


Fig. 10



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METHOD OF AND APPARATUS FOR SHAPING THE PROFILED SURFACE OF A ROTATING TOOL FOR PRODUCING CYCLOID THREAD FLANKS ON SCREWS

SUMMARY OF THE INVENTION

The present invention is directed to a method of and apparatus for shaping the profiled surface on a rotating tool which is used for the production of cycloid thread flanks on screws, and, more particularly, it is directed to a dressing device for shaping the profiled surface of the tool by moving the dressing device along a generated screw line of the screw to be produced.

In the manufacture of profiled rotating tools used for forming screw surfaces with a prescribed flank profile, a tool point has been used which moves rapidly in a reciprocal movement along a line of the desired screw profile during the manufacture of the tool while the tool blank rotates about its axis and performs a relative screw movement about the axis of the screw to be formed. Accordingly, the flank surface of the tool is formed by the combination of two movements, that is, the movement of the tool point and of the tool blank, and the movement of the tool point must be carried out in a rapid reciprocal movement along a curve controlled, for example, by a template. Due to the plurality of movements involved an accumulative error may occur, particularly since one of the movements must take place rapidly along a curve and, therefore, cannot be performed with the rigidity required for the formation of exact flank surfaces. Accordingly, the above method is limited in its use to the formation of screw surfaces with rectilinear generatrices.

The desired tool profile can be calculated and produced correctly with a template-controlled tool point. Apart from the inaccuracies which result from the manufacture of the template and from the transfer of its form to the movements of the tool point, a considerable number of templates must be manufactured for each flank profile that is to be produced, since the flank profile of the rotating tool changes constantly as its diameter decreases and must be recalculated. The problem of decreasing tool diameter is of particular concern in providing the proper profile for grinding disks.

Due to these difficulties, the formation of cycloid thread flanks has been carried out in two separate steps. Initially, the cycloid thread flank profiles have been formed by turning or milling on spindles and counter spindles. These rather inaccurate profiles were run continuously in a prolonged overlapping operation until the profiles approached the counter profiles. However, the lapping process caused undesired profile changes so that the resulting flanks of the spindles and counter spindles, such as in screw pump spindles, did not have the required precision.

Therefore, the primary object of the present invention is to provide a method of and apparatus for shaping the profiled surface of rotating tools, particularly, grinding disks, which are used in the formation of cycloid thread flanks on screws where a tool point affords the required profile on the rotating tool which is precise, produced economically and independently of the diameter of the tool.

The invention is applicable both to milling cutters and to grinding disks, and its particular advantage involves the formation of the profiled surfaces on grinding disks which permit the production of very precise cycloid thread flank profiles which do not require any subsequent overlapping to obtain the desired accuracy.

In accordance with the present invention, a dressing tool point is moved along a helical line as a generatrix which coincides with the helical line on the addendum circle of an imaginary counterscrew in engagement with the screw being produced, with the center spacing of the screw and the imaginary counter screw being equal to the dedendum radius of the screw and the addendum radius of the imaginary counterscrew.

The screw line formed is also a generatrix of the cycloid profile of the thread flanks on the screws being produced. When the tool point is guided along the screw line, it produces the requisite flank profile for the rotating tool without any additional movement. The form of the screw line and its location in space can be readily determined on the basis of the imaginary counterscrew. It is possible to adjust and produce the movement of the tool point along the generated screw line by mechanical operations.

When such a profiled rotating tool is used and is pivoted into the pitch angle of the screw to be formed, it produces precise cycloid thread flanks on the screw which would be in full engagement with the imaginary counterscrew. Conversely, the counterscrew could be produced in exactly the same manner if the tool point is moved along a generatrix which coincides with the screw line on the addendum circle of the screw, which has been produced but which could be assumed as imaginary.

When the profiled surfaces of grinding disks are shaped or dressed according to the present invention, they will produce the same cycloid thread flank profile independent of the diameter of the disk.

According to a preferred embodiment of the present invention, the generating screw line is tangent to the outer circumferential periphery of the rotating tool at a point within the periphery of the tool, particularly where a grinding disk is sued. In shaping the rotating tool, the dressing tool point is guided along the generating screw line up to the point of tangency, the movement along the screw line is interrupted and the tool point is displaced across the outer face of the tool in a plane which extends through the tool axis and the axis of the screw being produced and then the displacement along the screw line is continued. This shaping action performed on the profiled surface of the tool simplifies the manufacture of double-flanked tools, like grinding disks, and it affords the production of both the profiled flanks on the rotating tool along a screw line which is a generatrix of the cycloid thread flanks produced in the screw. This shaping step is possible in one operation, particularly in grinding disks, if the width of the tool corresponds to the width of the threaded groove being formed in the screw. Preferably, in carrying out the shaping operation, the movement along the screw line and across the face of the grinding disk is effected by three different dressing tool points which are brought into successive engagement with the profiled surface of the rotating tool.

The movement of the shaping tool along the generating screw line is performed at least within the range of engagement between the imaginary counterscrew and the screw being formed, because it is in this engagement range that the accuracy of the flank profile must be ensured.

Further, in accordance with the invention, the apparatus includes a dressing tool which supports at least one diamond dressing point and which is arranged in parallel relationship with the axis of the screw workpiece and is disposed in a plane which extends through the axis of the workpiece and of the grinding disk. The diamond dressing points are positioned opposite the surface of the grinding disk and the dressing tool is supported so that it can be pivoted to the pitch angle of the screw thread being formed and can be moved in the path of the generated screw line for dressing the profiled surface of the grinding disk. A novel feature of the dressing tool is its radially adjustable traverse which can be rotated about an axis falling within the periphery of the grinding disk for effecting the requisite movement for shaping the flanks of the profiled surface on the grinding disk. Further, the dressing tool includes slide conveyors which extend transversely of the axis of the tool and contain clamping means for setting the dressing points to the proper radius of the generating screw line. A drive means is connected to the dressing tool so that it can be pivoted for movement along the path of the generating screw line and the drive means is connected over change gears with a lead screw nut drive which provides another component of the movement of the dressing tool.

The drive means for the dressing tool includes a shaft supporting a control disk which has trip cams for limiting the pivotal or rotational movement of the dressing tool and also contains an index bore for a locking index pin magnet for controlling the lockinG-unlocking movement of the pin.

Preferably, the dressing tool includes a traverse bar on which three diamond points are mounted, located in the one plane and on the same radius, that is, two lateral points for shaping the flanks of the grinding disk and one front diamond point for shaping the profiled surface between the flanks. The trip cams on the control disk limit the dressing movements of the lateral diamond points which are locked on the traverse bar exactly on the flanks of the grinding disk by indexing means.

The dressing tool can be positioned on the front side, that is, the side of the grinding disk at which the workpiece is located or on the back of the grinding disk on the opposite side from the workpiece. The positioning of the dressing tool on the front side has the advantage of simplicity, however, there is also the disadvantage that the workpiece must be removed from between its head stock and tail stock to permit its replacement by the dressing tool. When the dressing tool is arranged on the back side of the grinding disk, it need not be replaced though a device must be provided for compensating for the decreasing size of the grinding disk.

Accordingly, a preferred embodiment of the apparatus according to the invention, involves the placement of the dressing tool on the back side of the grinding disk and the use of a compensating device for maintaining equal intervals between the workpiece axis and the grinding spindle axis as well as between a mirror image of the workpiece axis on the opposite side of the grinding disk relative to the grinding spindle axis. Further, the traverse bar of the dressing tool is positioned on a carriage for displacement parallel to the axis of the dressing tool. The carriage supports the pivot drive for the traverse bar, the change gears and a portion of the lead screw nut drive. The other part of the lead screw nut drive is located on an infeed carriage for the dressing tool for axial displacement on another carriage. Additionally, a cylinder-piston drive is positioned between the infeed carriage for the dressing tool and the carriage supporting the dressing tool which displaces the infeed carriage and the carriage for the lead screw nut drive and its movement is limited at its opposite ends by a pair of stops. During this displacement of the dressing tool carriage, it is locked against pivotal movement by an index means.

The dressing tool is displaceable in the direction of the grinding disk and is adjustable to the center distance between the screw being formed and the imaginary counterscrew.

The displacement of the dressing tool permits its proper placement with its axis relative to the mirror-image workpiece axis so that the correct profile can be formed on the grinding disk.

To provide the required locking-unlocking movement of the index means, a switching rod is mounted on the dressing tool carriage and has adjustable trip cams and a limit switch is located on the infeed carriage for displacement between the trip cams.

With the above described embodiment, the dressing tool can shape the grinding disk from the reverse side so that proper cycloid profile flanks are produced, simply by following a given screw line established as a generatrix on the imaginary counterscrew, while the workpiece is maintained in position on the front side of the grinding disk. In this arrangement, the dressing tool performs a counterclockwise screw movement when the imaginary counterscrew on the opposite side of the grinding disk is a right handed screw and vice versa. If the dressing operation is carried out on the front side of the grinding disk, the workpiece must be replaced by the dressing tool. In this case, the dressing tool is held and moved by the lead screw drive and the workpiece spindle drive which effect the movement along the generating screw line, the grinding disk, which is pivoted into the pitch angle of the screw, is displaceable in the direction of the workpiece axis and is adjustable to the center distance between the screw being formed and the imaginary counterscrew.

The shaped profile of the grinding disk in accordance with either embodiment for forming the cycloid thread flanks is the same.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWING

In the drawings:

FIG. 1 is a perspective representation of a screw having cycloid thread flanks and an imaginary counterscrew in engagement with the screw;

FIG. 2 is a schematic transverse view of the screws shown in FIG. 1;

FIG. 3 is a schematic illustration of a grinding disk shaped in accordance with the present invention, with a screw being formed at its periphery and the imaginary counterscrew in engagement with the screw being formed;

FIGS. 4 and 5 are schematic representations of a portion of the grinding disk shown in FIG. 3 indicating a path of travel of a dressing tool over the profiled surface of the disk;

FIG. 6 is a partial sectional view of a thread grinding machine seen from the rear and incorporating an embodiment of the apparatus according to the present invention, the view is taken along line VI—VI in FIG. 9;

FIG. 7 is a view, partly in section, taken along line VII—VII in FIG. 6;

FIG. 8 is a view of a control disk taken along line VIII—VIII in FIG. 7;

FIG. 9 is a partial sectional view taken along the line IX—IX in FIG. 6;

FIG. 10 is a view similar to FIG. 9 showing another embodiment of the apparatus in accordance with the present invention with the dressing operation being effected on the front side of the grinding disk; and

FIG. 11 is a view taken along the line XI—XI in FIG. 10.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1, a screw 1 formed with cycloid thread flanks 2 and 3 is shown in engagement with an imaginary counterscrew 1′ having similar cycloid thread flanks 2′ and 3′. The addendum radius of the imaginary counterscrew is designated as r_c and the dedendum radius of the screw to be produced is designated as r_f. The center-to-center distances between the axis 4 of the screw to be produced and the axis 4′ of the imaginary counterscrew is equal to the sum of the addendum radius r_c of the counterscrew and the dadendum radius r_c of the screw to be produced.

In the drawing, the imaginary counterscrew 1′ is shown in engagement with the screw to be produced and is represented as a finished-machined screw because of the representation of the generatrix. The generated screw line 5′ extends on the addendum circle 6′ of the imaginary counterscrew. In accordance with the method of the invention, a tool point for dressing a rotating tool is moved along the generatrix of the screw line in a single continuous movement for shaping the profiled surface of the rotating tool, which in turn produces the desired cycloid thread flank on the screw to be produced with great precision and independent of the diameter of the rotating tool.

By means of the method, in accordance with the present invention, it is possible to shape the profile forming surfaces of metal-cutting tools, such as milling cutters and grinding disks.

An example of cycloid thread flanks is shown in section in FIG. 2. The cycloid thread flanks of both the screw to be produced and the imaginary counterscrew are provided with hollow flanks. This is the case when two identical screws with the same number of teeth and the same addendum radius and dedendum radius are in mutual engagement, as in the embodiment set forth in FIG. 1. In other instances, the profiles of the cycloid thread flanks can change, for example, hollow thread flanks on one screw can engage convex thread flanks on the other screw. The method described herein can be utilized on rotating tools which form cycloid thread flanks whatever the flank profile may be. In any case, the generatrix used in providing the proper profile for the rotating tool is that part of the screw line 5' of the imaginary counterscrew which is in engagement with the screw to be produced. In FIG. 1, the portion of the screw line 5' bearing on the thread flank 3 is represented in a heavier line.

In FIG. 3, the position of the workpiece 1 in which the screw is to be formed, is shown on the front side of a grinding disk 7. For purposes of this description the side of the grinding disk 7 contacting the workpiece will be considered as its front side and the opposite side of the grinding disk will be considered as its rear side. The inclination of the grinding disk 7, which is obtained by pivoting it into the pitch angle of the screw 1, is not shown in FIG. 3. However, the angular inclination of the grinding disk can be seen in FIGS. 4 and 5. In FIG. 4, the grinding disk is shown in the direction of the arrow IV in FIG. 3 while in FIG. 5, a view of the rear side of the grinding disk is shown as represented by the arrow V in FIG. 3. In FIGS. 4 and 5, the workpiece is not represented for sake of simplicity.

In FIG. 3, on the left or front side of the grinding disk 7, the imaginary counterscrew 1' shown in phantom lines is illustrated in engagement with the workpiece 1. The screw line 5' shown in FIG. 1, appears as a circular line in FIG. 3 which is actually a spatial screw line. As shown in FIG. 3, the line of contact or the generated screw line extends between the points *a–b–c–d*. The generating screw line 5' contacts the outer circumferential periphery 7*a* of the grinding disk 7 at the points *b–c*. In double-flanked rotating tools, like grinding disks, there are two contact points *b* and *c* which define the limits of a line of contact on the outer circumference of the grinding disk with the line extending parallel to the axis of the workpiece and in a plane extending through the axis of the workpiece and the axis 8 of the grinding spindle of the grinding disk. From the contact point *c* the screw line continues to the contact point *d* on the outer edge of the grinding disk flank.

The center circle pitch angle or angle of lead of the workpiece is equal to the angle of angular displacement α of the grinding disk relative to the workpiece axis 4.

In the dressing operation on the grinding disk, the dressing tool travels along the path of the screw line 5' about the axis 4' of the imaginary counterscrew, as is shown in FIG. 3. In order to use the workpiece axis 4 as a pivot axis for the dressing tool point, the grinding disk would have to be displaced by the center-to-center distances of the axes 4–4' in the direction of the workpiece axis so that the dressing tool on the front side of the grinding disk can be used and replace the workpiece 1.

As an alternative to performing the dressing operation on the front side of the grinding disk 7, the path of travel of the dressing tool point can be applied in a mirror-image fashion to the back side of the grinding disk. This operation is represented schematically on the right side of FIG. 3, and by the generated screw line 5' shown in FIG. 5. When this alternate dressing operation is used, the workpiece need not be replaced on the front side of the grinding disk.

In the examples shown in FIGS. 4 and 5, the dressing tool point is moved along the generating screw line 5' in the same path of travel, the path in FIG. 5 being a mirror-image of that in FIG. 4. Initially, the dressing tool point moves from the contact point *a* and *a'* over the flank 9 of the grinding disk to the contact point *b*, *b'*, which as shown in FIG. 3, is located on the outer circumferential peripheral circle of the grinding disk. When the movement over the flank 9 is completed in passing from the contact point *a*, *a'* to the contact point *b*, *b'*, the movement along the screw line is interrupted and a transverse movement is imparted to the dressing tool in parallel relationship with the workpiece axis 4 until the dressing tool point reaches the contact point *c*, *c'* on the opposite side of the outer circumferential periphery of the grinding disk. When the contact point *c*, *c'* is reached the transverse movement is discontinued and the movement along the screw line 5' is continued over the opposite flank 10 of the grinding disk until the point *d*, *d'* is reached. The movement of the dressing tool point along the screw line 5' is terminated after the point *d*, *d'* has been passed, but not before this point has been reached. During this movement of the dressing tool point along the screw line the requisite shaping of the double-flanked profiled surface of the rotating tool is accomplished. Accordingly, the grinding disk 7 is dressed for the production of cycloid thread flanks.

The apparatus utilized in carrying out the invention will be described in relation to a thread grinding machine.

In FIGS. 6 to 9, a thread grinding machine 11 is shown having a machine frame 12 on which the workpiece carriage 13 supports a workpiece head stock 14 and a tail stock 15, note the showing of this feature in FIG. 11. A lead screw 16 and a lead screw nut 16*a* mounted in a conveyor 17 provide the longitudinal movement of the workpiece carriage 13 relative to the stationary grinding disk 7. As indicated in FIG. 6, the grinding disk 7 is pivoted into the pitch angle of the workpiece 1 in which the screw with cycloid thread flanks is to be formed. A workpiece spindle 18 provides the rotary drive for the workpiece 1 and the workpiece spindle is operatively connected over change gears 19 with the lead screw 16. The workpiece is clamped between the points 20 and 21 of the workpiece head stock and its tail stock, respectively, as can be seen in FIG. 11 and its rotary drive is transmitted over a follower, not represented. As represented, the grinding disk forms the full thread depth in the workpiece in each case. Means for grinding in several passes until the full thread depth is reached are known in themselves and are not shown.

In the embodiment illustrated in FIGS. 6 to 9, the dressing tool for shaping the circumferential periphery of the grinding disk is arranged on the back side of the grinding disk in the thread-grinding machine.

The grinding disk is mounted on a stand 22 which is adjustably positionable by means of a spindle nut 23*a* located on a compensating spindle 23 which in turn is connected through gear wheels 24 and 25 with a hand wheel 26, note FIG. 9. At its opposite end from the hand wheel 26, the compensating spindle is connected through gear wheels 27 and 28 with an infeed spindle 29 of a dressing tool. The nut 29*a* for the infeed spindle 29 is arranged on an infeed carriage 30. The infeed carriage 30 is supported on guides 31 formed on the stand 22. The guides 31 extend in parallel relationship with the compensating spindle 23 and the infeed spindle 29. On the guides 31 the infeed carriage 30 can be displaced in the direction of the grinding disk axis. The extent of displacement of the infeed carriage is determined by an end block 32 and a nose 33 which serves as a limit stop for the block. The setting of the infeed carriage 30 can be locked by means of a clamping lever 34.

On its upper surface, the infeed carriage 30 has a pair of spaced longitudinally extending guides 35 extending in a direction transverse to the direction of travel of the infeed carriage. A dressing tool carriage 36 is mounted on the guides 35 for movement in the direction of the guides. As shown in FIG. 6, another carriage 37, which is rigidly connected to a lead screw nut 38, is located on the infeed carriage 30 and is associated with the dressing tool carriage 36. A lead screw 39 in engagement with the lead screw nut 38 on the carriage 37 is secured to the dressing tool carriage 36 in such a manner that it cannot be displaced in the axial direction.

The rotary drive of the lead screw 39 is effected over exchangeable change gears 40, 41 and 42 associated with the dressing tool carriage 36. The gear wheel 40 is secured on the lead screw 39, the gear wheel 41 is an intermediate gear wheel and the gear wheel 42 is arranged on a pivot drive housing 43 which also carries an electric motor 44. A pivot drive 45, represented in a simplified form within the housing 43, drives a pivot shaft 46 over a known worm and gear drive in one or the other direction.

The simultaneous rotary drive of the pivot shaft **46** and the axial displacement of the dressing tool carriage **36** by the lead screw **39** and nut **38** effects a spacial screw movement which duplicates the movement along the generating screw line **5'** of FIG. **1**.

For effecting axial adjustment during the dressing of the end face *7a* of the grinding disk **7**, a cylinder-piston drive **47, 48** is positioned between the infeed carriage **30** and the dressing tool carriage **36**. The cylinder **47** is formed as a part of the infeed carriage **30**. A piston rod **49**, secured to the piston **48**, is rigidly connected at its other end to the dressing tool carriage **36**. Pressure medium lines **50, 50a** are connected to the cylinder **47** for effecting the displacement of the piston **48**. The pressure medium lines are reversible by means of a reversing valve which is not shown in the drawing. The shifting or displacement movement of the cylinder-piston drive is limited at each end by a stop **51** and **52** which are located on the opposite sides of the carriage **37** and inside the guides **35** on the infeed carriage **30**. The stops **50, 51** are adjustable and can be locked in place by clamping levers **53, 54**, respectively.

As shown in FIG. **6**, the carriage **37** with the nut **38** bears along the right hand side against the stop **51**. At the opposite side of the carriage **37**, a free path **55** extends between it and the other stop **52** and this free path corresponds to the displacement path of the dressing tool carriage. When the carriage **37** has traversed the free path **55** it bears against one of the stops **51, 52**.

On the right hand side of the dressing tool carriage **36** in FIG. **6**, a switching rod **56** which is rigidly connected to the carriage, extends outwardly from it and supports two adjustably positionable trip cams **57** and **58** which are arranged to actuate a limit switch **59** supported on a bracket **60** mounted on the infeed carriage **30**. The spacing between the trip cams **57, 58** corresponds to the free path **55** and when the path has been traversed the limit switch **59** is actuated. The function of the limit switch will be explained later.

A dressing tool for shaping the profiling surfaces of the grinding disk is generally designated by **61** and includes a traverse bar **63** which is rotatable about a dressing tool axis **62** which is located in a similar position to the axis of the imaginary counterscrew **1'** on the opposite side of the grinding disk, that is, the rear side of the grinding disk. The traverse bar **63** is adjustable in the radial direction from the dressing tool axis **62**. As shown in FIG. **7**, the traverse bar has a pair of oppositely disposed right-angled side members **64** and **65** which can be adjusted radially in equi-directional slide conveyors **66, 67** by means of end blocks **68, 69** which are clamped by means of levers **70, 71**, respectively. As indicated in both FIGS. **6** and **7** the traverse bar is rigidly connected at one end to the pivot shaft **46** and at its opposite end it is mounted in a step bearing **72** by means of a journal **73**. The axis of the bearing coincides with the axis **62** of the dressing tool.

The traverse bar carries two side holders **74, 75** which are angularly offset toward the grinding disk at their ends spaced from the traverse bar. The holders **74, 75** are supported in axially directed coaxial receiving bores **76, 77**, respectively, located within the traverse bar and the holders can be adjusted within the bores. Approximately in the center of the traverse bar a guide **78**, extending in the direction of the bar, is arranged for holding a central holder **79**. The side holders **74, 75** contain the diamond dressing points **80, 81**, respectively, and a center diamond dressing point **82** is positioned in the holder **79** located between the two side holders. The three diamond dressing points **80, 81** and **82** are arranged in the same plane and on the same radius relative to the dressing tool axis and are set in exact dressing positions relative to the surface of the grinding disk by means of the slide conveyors **66, 67** and their end blocks **68, 69**. The diamond dressing points are located on the addendum radius which corresponds to the addendum radius of the imaginary counterscrew and corresponds to the radius of the generating screw line **5'**. As mentioned previously, the location of the dressing tool axis **62** corresponds to the location of the axis **4'** of the imaginary counterscrew **1'** in FIG. **1** on the rear side of the grinding disk.

The control of the positioning of the three diamond dressing points is provided by a control disk **83** rigidly mounted on the pivot shaft **46**, note FIG. **7**. An arcuate guide groove **84** (FIG. **8**) forming a portion of a circle is located near the outer edge of the control disk and a pair of trip cams **85, 86** are arranged in locked positions within the guide groove. The trip cams limit the pivotal movement of the traverse bar **63** for the two lateral diamond dressing points **80, 81** which are located for engagement with the opposite flanks of the grinding disk **7**. A limit switch **87** is associated with the control disk for discontinuing the pivotal movement at the required time. Accordingly, the pivot drive motor **44** can be disconnected or a clutch provided in the pivot drive **45** so that it can be disengaged.

In relation to the path of the dressing tool shown in FIG. **5**, when the dressing operation is performed on the rear side of the grinding disk **7**, the pivotal movement is interrupted in the center position, after the distance *a'–b'* has been covered, by a controlable index. The control disk **83** contains an index bore **88** arranged to receive a lockable index pin **89**. The index pin **89** is connected to a pull magnet winding **91** and is excited when the limit switch **59** is actuated by the trip cam **58**. The index pin **89** can be pulled from the index bore **88** by the magnet **90**. The locking action on the index pin can be effected by a spring, not represented.

When the locking movement of the index pin is effected, the control disk **83** is locked in its center position. The locked index pin actuates a contact **92** for disconnecting the motor **44** and reversing the pressure medium which admits the pressure medium to the right side of the piston **48** as shown in FIG. **6**, and displaces the dressing tool carriage **36** in the leftward direction toward the end stop **52**. In the course of this transverse movement the end face *7a*, that is, the outer circumferential periphery of the grinding disk is dressed by the central diamond dressing point **82** and the diamond dressing point **81**, located on the right hand side in FIG. **7**, is displaced to the left for dressing the flank **10** of the grinding disk **7**. When this transverse dressing action is completed, the trip cam actuates the limit switch **59** and the pull magnet is actuated and withdraws the index pin **89** out of its bore and at the same time connects the pivot drive for continuing the pivotal or rotational movement of the traverse bar. The pivot drive is interrupted by the limit switch **87** when the limit switch is actuated by the trip cam **86**.

It should be mentioned that the pull magnet **90** and the index pin **89** are supported on a bracket **93** which is secured to the interior of the pivot drive housing **43**. The index **89** is aligned with the index bore **88**.

In FIG. **6**, the support and drive for the adjustable grinding disk is shown. A grinding spindle **94** for the disk rests in a spindle housing **95** on which a spindle motor **96** is mounted.

The dressing tool **61** located on the rear side of the grinding disk, as shown in FIGS. **6** to **9**, has its own drives substantially similar to those of the thread grinding machine. Accordingly, the dressing tool can perform and control the movements of the diamond dressing points in the sense of a screw movement corresponding to the generating screw line **5'**. In FIGS. **10** and **11** a simplified embodiment of the invention is provided where the dressing tool **61** is located on the front side of the grinding disk and replaces the workpiece **1**. In this arrangement, an infeed spindle **23'** is threaded into a spindle nut *23a'* which in turn is rigidly connected with the stand **22**. The rotary drive for the spindle **23'** is provided over the gear wheels **24', 25'** by an infeed hand wheel **26'**. The traverse bar **63** of the dressing tool **61** is located between the support points **20, 21** of the workpiece head stock **14** and the tail stock **15** after the workpiece **1** has been removed, note FIG. **11**. In this arrangement, the control disk **83** is positioned on the workpiece spindle **18** and its trip cams **85** and **86** along with the index bore **88** control the pivotal movement of the workpiece spindle **18** between the two end positions of the traverse bar **63** into the center position as indicated in FIG. **10**, and the pivotal movement of the traverse bar is indicated by the arrow **97**, starting at the upper most position of the traverse bar **63** shown in dash lines moving to the position shown in full lines with the diamond point **82** contacting the grinding disk and then into the other end position also shown in dash lines. Instead of the lead screw **39** and its nut **38**, as shown in the embodiment in FIGS. **6** to **9**, the lead screw **16** and its nut **16***a* are used in the positioning operation. By means of the infeed spindle **23'** the grinding disk **7**, pivoted into the pitch angle of the screw to be produced, is displaced in the direction of the workpiece axis **4**, as can be seen from FIG. **10**. The dressing operation on the surface of the grinding tool takes place in accordance with the arrangement shown in FIG. **4**. The axial movement of the three diamond dressing points for trimming the outer circumferential peripheral face **7***a* of the grinding disk can be effected by the central diamond point **82** in the simplest case by means of the existing lead screw **16** and nut **16***a* if the operative connection is interrupted at the same time over the change gears **19** by temporary disengagement. Naturally, a cylinder-piston drive, corresponding to that shown in FIG. **6**, could also be utilized.

After the grinding disk has been dressed, the stand **22** is moved back by the amount of its previous displacement. The traverse bar **63** is replaced by the workpiece to be ground. A compensating device is not required in this embodiment because the compensation is effected automatically.

What is claimed is:

1. A method of shaping the profiled surfaces of a rotating tool, particularly a grinding disk, with a tool shaping point, where the profiled surfaces are used for the production of cycloid thread flanks in screws mounted for rotation about a workpiece axis spaced from the rotation axis of the tool, said method comprising rotating the tool about its rotation axis; and, during such rotation, moving a tool shaping point, in contact with the profiled surfaces of the tool, along a helical line, serving as a generatrix, whose axis is parallel to such workpiece axis and spaced from such workpiece axis by a distance equal to the sum of the dedendum radius of the screw to be produced and the radius of the helical line.

2. A method, as set forth in claim **1**, comprising locating such helical line, serving as a generatrix, internally tangent to the circumferential peripheral surface of the rotating tool; guiding the tool shaping point along such helical line up to the point of tangency of such helical line with the circumferential peripheral surface of the rotating tool; interrupting movement of the tool shaping point along such helical line; guiding the tool shaping point across the circumferential peripheral surface of the rotating tool between the profiled surfaces of the rotating tool; and then resuming guiding of the tool shaping point along the other profiled surface and following such helical line.

3. A method, as set forth in claim **1**, comprising the step of guiding the tool shaping point over that surface of the rotating tool which contacts the thread flanks, of the screw to be produced, in at least the range of engagement of such thread flanks with the thread flanks of an otherwise identical counterscrew.

4. A device for shaping the profiled surfaces of a rotating tool, such as a grinding disk, used for the formation of screw threads in a screw having cycloid thread flanks, said device comprising, in combination, means, including a supporting spindle, for mounting a grinding disk in position to form the screw threads and for pivoting of the disk into the pitch angle of the screw to be formed, said spindle rotatably supporting the grinding disk; a traverse bar mounted for angular displacement about an axis parallel to the axis of said spindle and positioned between said traverse bar and the axis of said spindle; means mounting said traverse bar for adjustment radially of its axis of angular displacement; at least one tool dressing member mounted on said traverse bar for engagement with the surface of said disk to shape the same; and means operable to displace said traverse bar angularly about its axis of angular adjustment and longitudinally parallel to its axis of angular adjustment; said last-named means effecting movement of said dressing member along a helical line, serving as a generatrix.

5. A device for shaping the profiled surface of a rotating tool, such as a grinding disk, which is used for the formation of screw theads in a screw which have cycloid thread flanks, comprising means for mounting a grinding disk in position to form screw threads so that the disk can be pivoted into the pitch angle of the screw to be formed, said means comprising a spindle for rotatably supporting the grinding disk; means for dressing the circumferential periphery of the disk comprises a traverse bar rotatably mounted for angular displacement in a plane extending perpendicularly across the axis of said spindle for the disk and the axis of rotation of said traverse bar is located between said spindle and said traverse bar, said traverse bar being radially adjustable relative to its axis of rotation, at least one dressing member mounted on said traverse bar for shaping the surface of the disk, means displacing said traverse bar in a direction parallel with the axis of said spindle; a drive means operatively associated with said traverse bar for rotating it about its axis of rotation, said drive means including a control disk for regulating the rotational movement of said traverse bar, said control disk comprising a pair of spaced trip cams and an index bore, a limit switch arranged to be actuated by said trip cams for discontinuing the rotational movement of said traverse bar, an index pin arranged to be inserted into and removed from said index bore in said control disk, and electromagnetic means associated with said pin for effecting its movement into and out of said bore.

6. A device, as set forth in claim **5**, wherein two side dressing members are mounted on said traverse bar and a center dressing member is mounted on said traverse bar between said side dressing members, said center and side dressing members extending in one plane across said traverse bar and disposed at the same radius from the axis of rotation of said traverse bar, said control disk arranged to regulate the movement of said dressing members in contact with the circumferential periphery of the grinding disk, and means incorporated in said traverse bar for exactly positioning said dressing members for contact with the circumferential periphery of the grinding disk.

7. A device, as set forth in claim **6**, wherein said traverse bar is arranged on the opposite side of said grinding disk from the screw to be produced and the axis of rotation of said traverse bar is located in a plane including the axis of said workpiece and the axis of said spindle for said grinding disk, a compensating device for maintaining the position of said dressing members relative to the circumferential periphery of the grinding disk with relationship to the spacing of the axis of the grinding disk and the screw being formed, and means in operative engagement with said drive means for rotating said traverse bar and arranged for displacing said traverse bar in a direction parallel to the axis of rotation of said traverse bar for effecting with said drive means the dressing movement of said dressing members over the surface of the grinding disk.

8. A device, as set forth in claim **7**, wherein said drive means for rotating said traverse bar comprises a dressing tool carriage, a shaft mounted in said carriage for rotating said traverse bar, a drive assembly including a motor operatively connected to said shaft for rotating said traverse bar, and said means for displacing said traverse bar parallel to its axis of rotation comprises a support carriage arranged for movement perpendicularly to the axis of rotation of said traverse bar, an intermediate carriage mounted on said support carriage and arranged for movement in a direction perpendicular to the direction of movement of said support carriage, a lead screw secured to said dressing tool carriage and engaged with said intermediate carriage, a change over gear assembly operatively connected to said drive assembly for rotating said traverse bar and in communication with said lead screw engaged within said intermediate carriage for moving said traverse bar parallel to its axis of rotation during its rotational movement, and a cylinder-piston drive assembly comprising a cylinder secured to said support carriage, a piston axially displaceable through said cylinder in a direction parallel to the axis of rotation of said traverse bar, a piston rod secured to said piston within said cylinder at one end and to said dressing tool carriage at the other end whereby said dressing tool carriage can be displaced in a direction parallel to the axis of rotation of said traverse bar.

9. A device, as set forth in claim **8**, wherein adjustable stop means are mounted on said support carriage for limiting the movement of said dressing tool carriage in the direction parallel to its axis of rotation.

10. A device, as set forth in claim **9**, wherein a switching rod is secured to and extends outwardly from one side of said dressing tool carriage in a direction extending parallel with its axis of rotation, a pair of trip cams spaced apart on said switching rod, and a limit switch secured to said support carriage and positioned in the path of movement of said trip cams when said dressing tool carriage moves in a direction parallel with the axis of rotation of said traverse bar, said limit switch arranged in communication with said control disk for effecting the locking of said index pin within the bore in said control disk.

11. A device, as set forth in claim **6**, wherein means are arranged for holding a workpiece relative to the means for rotatably mounting a grinding disk for forming screw threads in the workpiece, said means for holding the workpiece comprising a head stock, and a tail stock, said traverse bar being positionable between said head stock and tail stock when the workpiece is removed for effecting the dressing of the circumferential peripheral surface of the grinding disk, drive means associated with said head stock for rotating said traverse bar, said control disk mounted on said means for rotating said traverse bar, a lead screw drive assembly secured to said head stock and tail stock for displacing said workpiece in its axial direction and said assembly arranged to displace said traverse bar in the direction parallel to its axis of rotation for effecting the dressing movement of said dressing members over the surface of the grinding disk and means for supporting said spindle for the grinding disk so that it is displaceable in a direction perpendicular to the axis of rotation of the workpiece.

12. A device for shaping the profiled surface of a rotating tool, such as a grinding disk, which is used for the formation of screw threads in a screw which have cycloid thread flanks comprising a machine frame, a stand mounted on said machine frame, for movably supporting the rotating tool, a first spindle secured within said machine frame, a first spindle nut attached to said stand and in threaded engagement with said first spindle for movably positioning said stand, a support carriage movably positioned on said stand and displaceable thereon in the direction perpendicular to the axis of the rotating tool, a first gear wheel assembly secured to one end of said first spindle for positioning said stand, a second spindle, a second spindle nut attached to said support carriage and in threaded engagement with second spindle for movably positioning said stand, a second gear assembly operatively connected to the other end of said first spindle and to said second spindle for compensating movements by said support carriage in relationship to the positioning of said stand, a dressing tool carriage movably supported on said support carriage for movement in a direction parallel to the axis of the grinding disk, an intermediate carriage positioned on said support carriage, a lead screw nut rigidly affixed to said intermediate carriage, a lead screw rotatably attached to said dressing tool carriage and in threaded engagement with said lead screw nut for displacing said dressing tool carriage, a drive housing positioned on said dressing tool carriage, a drive motor located on said drive housing, a drive means located on said drive housing in operative engagement with said drive motor, a dressing tool mounted on said dressing tool carriage and in engagement with said drive means for rotating said dressing tool about an axis spaced from and in parallel relationship with the axis of the grinding disk, a cylinder-piston drive assembly secured to said support carriage and to said dressing tool carriage for displacing said dressing tool carriage in a direction parallel to the axis of the grinding disk, said cylinder-piston drive assembly comprising a cylinder attached to said support carriage, a piston movably displaceable within said cylinder in a direction parallel to the axis of the grinding disk, a piston rod attached at one end to said piston and at its other end to said dressing tool carriage for displacing said dressing tool carriage when said piston is displaced within said cylinder, and control means for selectively regulating both the rotational motion and the motion parallel to the grinding disk axis of said dressing tool for shaping the profiled surface of a rotating tool mounted on said stand.

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