Oct. 26, 1948. K. W. J. HJELMBLAD 2,452,123

ARRANGEMENT IN GRINDING MACHINES

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Fig. 1

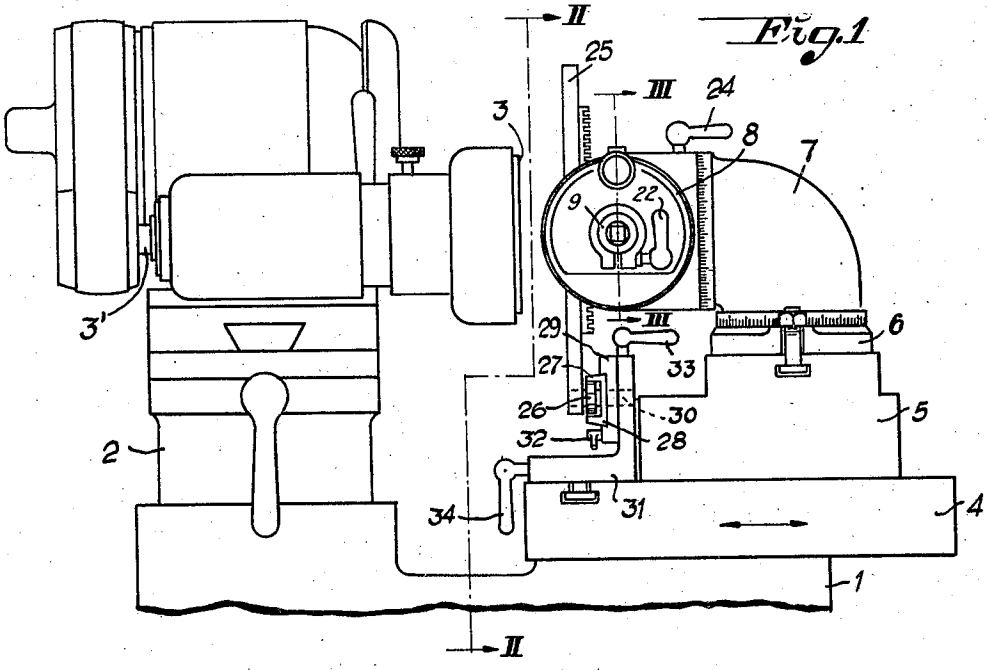
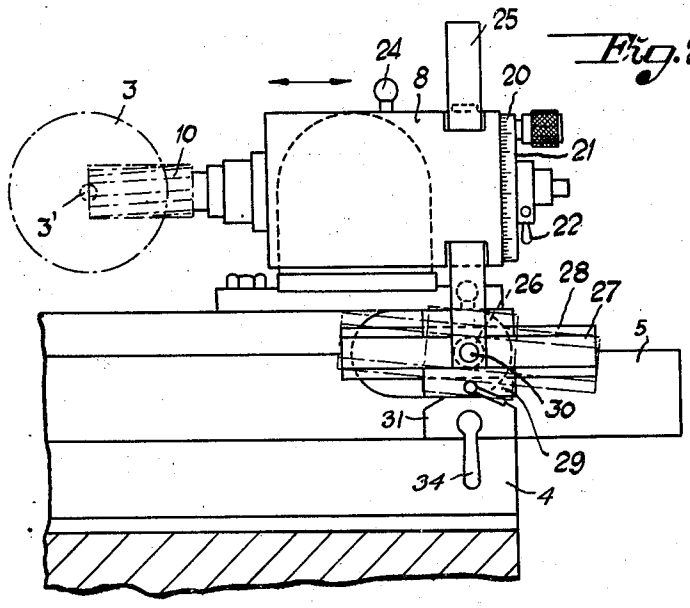



Fig. 2




INVENTOR
Karl Wilhelm Josef Hjelmblad

By Pierce & Scheffler
Attorneys

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Fig. 3

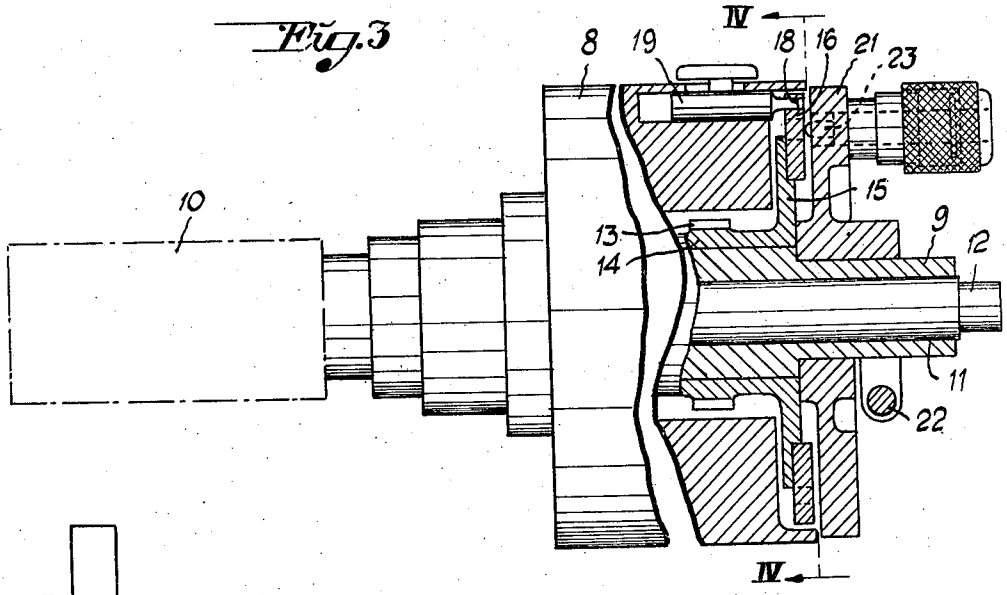



Fig. 4

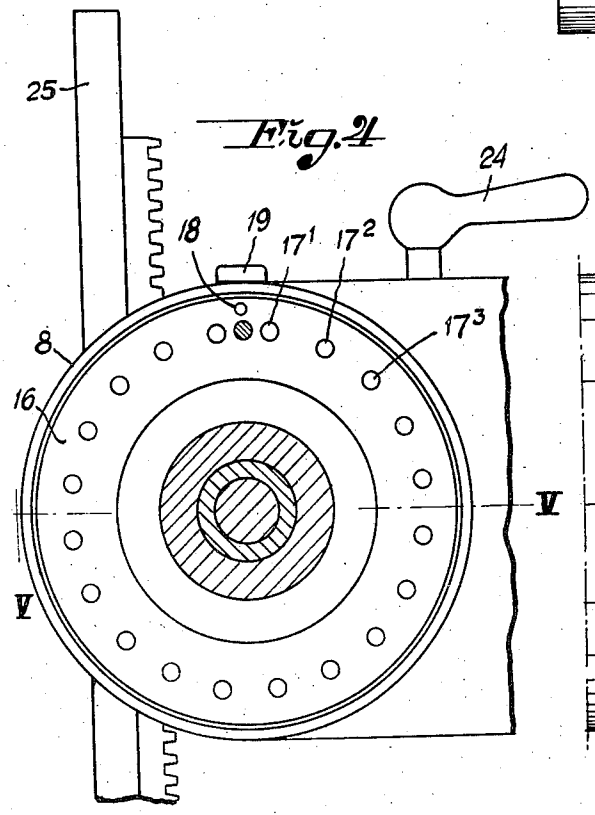
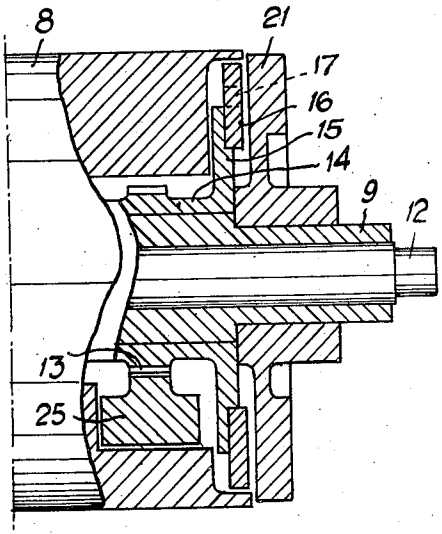



Fig. 5




INVENTOR
Karl Wilhelm Josef Hjelmblad

By Pierce & Scheffler
Attorneys

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Fig. 6

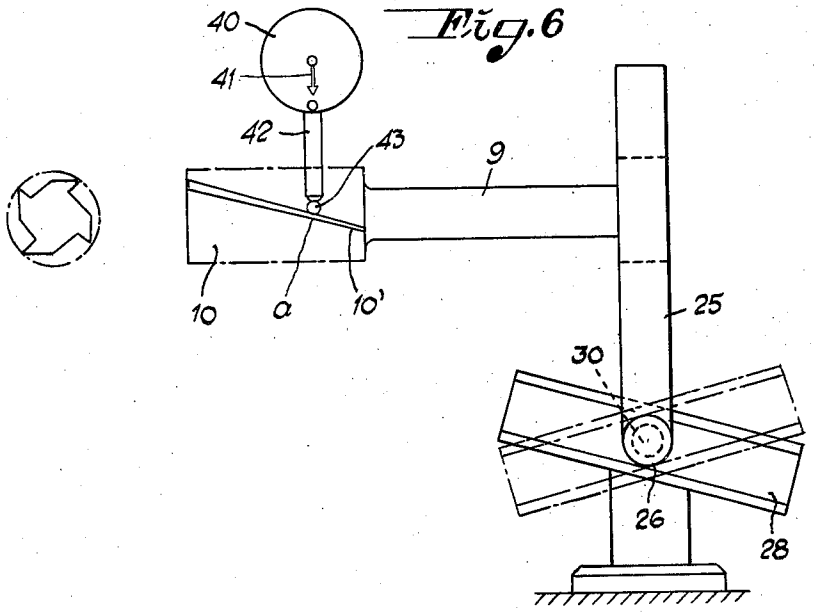
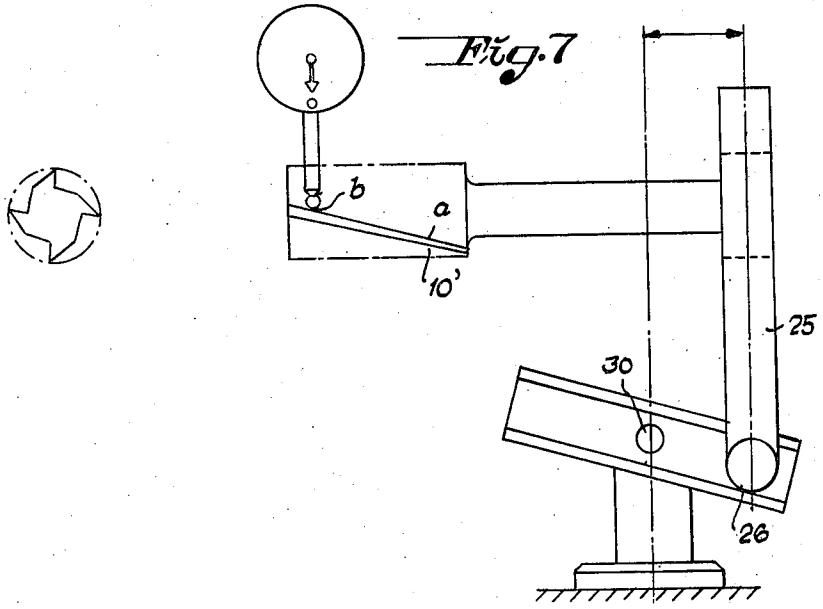



Fig. 7




INVENTOR
Karl Wilhelm Josef Hjelmblad
By Pierce & Scheffler
Attorneys

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## ARRANGEMENT IN GRINDING MACHINES

Karl Wilhelm Josef Hjelmblad, Alsten, Sweden

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6 Claims. (Cl. 51—123)

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The present invention relates to a grinding machine, wherein an adjustable lead unit is adapted to control that relative movement of a member carrying the lead unit, on the one hand, and the grinding tool, on the other hand, through which the surface to be ground or the edge of the work piece and the operating surface of the grinding tool are moved along one another to perform the grinding operation. Through the lead unit the work piece will have imparted thereto a positive guidance by which the work piece and the grinding tool are moved in the proper manner relatively to each other to obtain the desired grinding result.

The arrangements hitherto employed to effect a positive guidance of the work piece and the grinding tool show a number of drawbacks. In known grinding machines with a lead unit in the sense here implied, the adjustment of the lead unit to adapt the movement of the work piece to the shape of the edge of the work piece to be ground is complicated and time-wasting, inasmuch as it generally requires a plurality of tedious adjusting operations.

According to the invention, the lead unit is not adjusted by reference to graduated scales but is adjusted according to the work piece itself. The mechanism for transmitting motion between the sine bar of the lead unit and the work-carrying spindle includes two relatively adjustable members which form a dividing or indexing unit of known type by which the spindle is adjusted angularly to present different areas, for example the several cutting edges of a drill or milling cutter, to the grinding tool. The new method of adjusting the sine bar from the work pieces itself is made possible by the provision of latch mechanism for temporarily locking one member of the dividing unit to the movable carrier in a predetermined initial position, and by so constructing the lead unit that the motion-transmitting mechanism can be adjusted to an initial "neutral" relationship in which the sine bar may be moved angularly without effecting any movement of the motion-transmitting mechanism. The manner in which these predetermined initial settings may be employed to adjust the sine bar of the lead unit will be described in detail hereinafter.

According to the invention, the lead unit is so constructed as to have a position, the initial position, in which the member carrying the work piece during the grinding operation remains unactuated at an alteration of the adjustment of the lead unit to provide for adaptation to the

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shape of the edge or surface of the work piece to be ground. Thus there will aways be a definite initial position of the lead unit, according to which the member carrying the work piece may be adjusted. The lead unit may be in such motion-tranmitting connection with the member carrying the work piece that the initial position of the lead unit corresponds to a definite position of said member. The motion-transmitting connection may comprise adjusting members facilitating an accurate adjustment of the work piece relatively to the initial position of the lead unit. According to the invention, it is possible to adjust the lead unit to the shape of the edge to be ground, so that the lead unit will in the subsequent grinding operation guide the work piece relatively to the grinding disk in exact correspondence to the shape of the edge.

A great variety of work pieces may be ground in a grinding machine according to the invention, but the invention involves special advantages in the grinding of toothed tools, such as cutters, reamers and the like with obliquely cut teeth, although the invention is also applicable to straight teeth. As an example to facilitate an understanding of the description of the invention, the work piece is taken to consist of a cylindrical cutter with obliquely cut teeth. Expressions such as "the shape of the edge or surface of the work piece to be ground" as used in the preceding paragraphs, in a cutter of this kind refer to the peripheral shape and pitch of the cutter tooth. It is conceivable within the scope of the invention to arrange the grinding tool (the grinding disk) in such manner that the grinding tool is adjusted and guided by the lead unit, so that it will move along the tooth of the work piece during the grinding operation, which work piece may then be stationary relatively to the machine frame, but since the grinding tool must also have its operating movement (rotation in the case of a grinding disk), it will be found simpler to provide the adjustability in the member carrying the work piece. In a corresponding form of embodiment, said work piece is therefore provided with a plurality of parts adjustable relatively to each other above all an operating spindle, on which the work piece may be clamped, and a head in which the operating spindle is mounted. The head may be secured to a table which is movable along a rectilinear guide, and the operating spindle is turned by a drive from the lead unit, when the table is moved along its rectilinear guide during the grinding operation. The movement of the work piece during the grinding

operation may thus be regarded as being composed of the rectilinear movement of the table and the rotary movement of the operating spindle.

An example of the application of the invention is illustrated in the accompanying drawings. Fig. 1 is an endwise view of a universal tool grinding machine to which the invention is applied. Fig. 2 is an elevation of a detail of the machine. Fig. 3 is an elevation to a larger scale, partly in section through the dividing head of the machine. Fig. 4 shows a section on line IV—IV in Fig. 3, and Fig. 5 is a horizontal section on line V—V in Fig. 4. Figs. 6 and 7 are diagrammatic views of the lead unit and the spindle with the work piece in two positions of adjustment and have for their object to illustrate the mode of adjustment.

In the drawings, 1 designates the machine frame with a standard 2 adapted to be raised and lowered, said standard carrying the grinding tool, which here takes the form of a rotary grinding disk 3. The frame carries a transverse slide 4, which is displaceable in a manner known per se by means of a hand wheel, not shown, in a direction toward and from the grinding disk 3, said slide supporting a table 5, which is displaceable by means of a hand wheel, not shown, in a direction at right angles to the direction of movement of the transverse slide 4. Secured on the table 5 is a plate 6 adapted rotatably to support an angular piece 7 arranged to be locked thereto, said angular piece having, in turn, a dividing head 8 rotatably secured thereto, which head is adapted to be locked in said angular piece and carries a hollow spindle 9, onto which a tool 10 as indicated by chain-dotted lines may be clamped in a manner known per se by means of a rod 12 extending through the central hole 11 of the spindle 9. The spindle 9 carries a gear wheel 13 freely rotatable thereon, the hub 14 of said gear wheel being provided with a flange 15, to which is exchangeably secured a dividing plate 16 with dividing apertures $17^1$, $17^2$, $17^3$ and so forth and with a locking aperture 18 adapted to receive a latch 19 arranged on the dividing head 8, when the dividing plate is in its zero position. Freely rotatable on the spindle 9 is a carrier disk 21 with a graduation 20, said carrier disk being adapted to be locked to the spindle 9 by means of a handle 22. The carrier disk 21 is provided with a stop pin 23, which is adapted to engage the dividing apertures 17 so as to couple the carrier disk to the dividing plate in different relative angular positions.

The dividing head 8 is provided with a handle 24 to lock the spindle 9 to the head. The dividing head 8 also has a toothed rack 25 vertically displaceable therein, said rack engaging the gear wheel 13 and being displaceable by means of a lead unit. The latter consists of a supporting roller 26 arranged on the lower end of the toothed rack and engaging a guide slot 27 in a guide bar 28. The guide bar is displaceably mounted in an attachment 29, which is secured to a holder 31 by means of a journal 30 so as to be swingable in the vertical plane, said holder being arranged on the transverse slide 4 and adapted to be displaced at right angles to the direction of movement of this slide. The guide bar 28 is adapted to be locked to its attachment 29 by means of a handle 32, while the attachment 29 is adapted to be locked to the holder 31 by means of a handle 33 and the holder 31 is adapted to be locked to the transverse slide 4 by means of a handle 34.

The mode of operation of the arrangement is as follows, for instance in the grinding of a spiral cut cutter or reamer:



The work piece, i. e. the cutter 10, is clamped in any suitable manner in the spindle 9 of the dividing head 8, whereupon the spindle 3' (see Fig. 2) of the grinding disk 3 is adjusted into the proper vertical position relatively to the spindle 9 of the dividing head 8 by the standard 2 being raised or lowered. The table 5 is moved in such manner that the supporting roller 26 on the toothed rack 25 will be situated opposite the shaft 30. In other words, the centre of that member, the supporting roller 26, through which the transmission means formed by the toothed rack 25 and the gear wheel 13 is in engagement with the guide bar, will in this position be on the axis of rotation of the guide bar 28 (compare Fig. 6). In said position, a swinging movement of the guide bar about the centre line of the shaft 30, for instance from the position shown by full lines into the position indicated by chain-dotted lines in Fig. 6, does not entail any movement of the toothed rack 25 and, consequently, the angular position of the work piece 10 also remains unaltered at such swinging movement. In said position of the guide bar and the roller, that is to say in the initial or neutral position of the lead unit, the aperture 18 of the dividing plate 16 secured on the gear wheel 13 will be opposite the latch 19 which engages into and locks the dividing plate to the dividing head 8. The dividing plate will thus be in a zero position corresponding to the initial position. The work piece is now to be adjusted into a corresponding suitable initial position. To this end, the spindle 9 and the work piece 10 carried thereby are released from the dividing head 8 by loosening of the handle 24 and the carrier disk 21 is released from the spindle 9 by loosening the handle 22. The released spindle 9 is now turned so that a suitable point $a$ on the edge of a tooth 10' (Fig. 6) of the cutter 10 will be situated at the proper level, for example as high as the centre line of the spindle 9, for engagement by the grinding disk 3. In the case of a straight cylindrical grinding disk, this level is also as high as the centre line of this disk as previously adjusted to the level of the centre line of the spindle. This adjustment may be effected with the aid of an indicator of any suitable kind adapted exactly to indicate the level of the spindle centre. In Figs. 6 and 7, this indicator takes the form of a device including an indicator dial 40, which is to be secured to the machine frame or, in the case of a grinding disk with an adjustable bearing holder, to this holder by means of a swingable arm, by which it is kept in the indicating position in such manner that its pointer 41 points at zero or some other known position when the ball 43 of the indicator rod 42 has its bearing point located exactly on a level with the centre line of the spindle 9. The carrier disk 21 which is now free from the spindle is adjusted into the zero position by the stop pin 23 being introduced into the aperture 17' of the dividing plate 16 previously adjusted in the zero position, whereupon it is locked to the spindle 9 by means of the handle 22. The spindle with the work piece, the carrier disk, the dividing plate and the lead unit now take the proper initial positions relatively to each other and are maintained in these positions. It should be noted that the table 5 carrying the spindle cannot be displaced in the longitudinal direction of the spindle, since this is prevented by the obliquely positioned guide bar. Only if

the latter is adjusted in parallel to the axial direction of the spindle, or the direction in which the table 5 is guided on the transverse slide 4, will such movement be possible when the latch 19 is, as specified above, in locking engagement with the dividing plate.

It now remains to impart to the guide rail the inclination corresponding to the inclination of the tooth 10' on the tool or—more generally expressed—to adapt the adjustment of the lead unit to the shape of the tooth. To this end, the latch 19 is first disconnected to permit the spindle 9 and the parts coupled thereto to move freely. Furthermore, the handle 33 is loosened, so that the attachment 29 of the guide rail 28 and thus the guide rail may turn about the shaft 30. The table 5 is now displaced, so that another point *b* of the tooth 10' is brought into contact with the ball 43 of the indicator, as will appear from Fig. 7. By turning the carrier disk 21 coupled to the dividing plate 16 by means of the stop pin 23, the spindle 9 is now turned so that the point *b* of the tooth will be situated on the same level as in the first indication, that is to say so that the indicator pointer 41 is returned to zero. This turning movement of the spindle 9 and work piece 10 can be readily effected since the pinion 13 and rack 25 constitute a two-way motion-transmitting connection between the work spindle and the guide rail when the latter is released for angular adjustment by turning the handle. At the completion of the turning of carrier disk 21 by stop pin 23, the several elements are in the positions shown in Fig. 7, and it will appear from the end projections of the work piece shown to the right in Figs. 5 and 7 by how great an angle the work piece has been turned. At the displacement of the table 5, the toothed rack 25 obviously followed in the movement, and the supporting roller 26 was then carried along the guide rail 28 to a position spaced from the shaft 30. At the turning of the spindle by means of the carrier disk for the adjustment of point *b* to the proper vertical position, the toothed rack and the supporting roller therefore adjusted the guide rail 28 into the proper position corresponding to the inclination of the tooth 10', whereupon the guide rail is to be locked by means of the handle 33. Now, the guide rail has the proper angle of adjustment relatively to the cutter tooth, so that the spindle 9 will be adjusted angularly upon displacement of the table 5 to bring all parts of the tooth in the longitudinal direction thereof contact with the grinding disk at the same level.

During the grinding operation, the table 5 is moved to and fro, the toothed rack having then imparted thereto a movement up and down, which is transferred to the spindle and to the work piece through the gear wheel, the dividing plate and the carrier disk. Apertures of the dividing plate are disposed in correspondence to the teeth of the work piece. When a tooth is ground, no other adjustment is called for prior to the grinding of the next tooth than that the stop pin 23 is moved from the hole $17^1$ to the hole $17^2$ in the dividing plate, the carrier disk 21, which is still locked to the spindle 9, being thus caused to turn the latter and the work piece by a corresponding angle, so that the new tooth will be brought into the proper position relatively to the grinding disk. The grinding of this tooth then proceeds in the same manner as the grinding of the first tooth.

The arrangement described also involves the advantage that the work piece may be adjusted exactly for the grinding of any desired clearance



angles of the teeth. This may be effected with the aid of the carrier disk, on the graduation 20 of which the adjusted angle can be easily read off. The adjustment is effected so that the table 5 is displaced until the carrier disk is in the 0-position, whereupon the dividing plate 16 is controlled by the latch 19 and the spindle 9 is locked by means of the handle 24. The carrier disk 21 is loosened from the dividing plate 16 by the stop pin 23 being withdrawn and from the spindle by means of the handle 22 and is now turned in a counter-clockwise direction, Fig. 1, by the number of degrees desired for the clearance angle, and is again locked to the spindle 9. The spindle 9 is released by means of the handle 24, whereupon the carrier disk 21 is returned to the 0-position and locked to the dividing plate 16 by means of the stop pin 23. After that, the dividing plate 16 is released by the latch 19 being withdrawn.

The invention is not limited to the example of embodiment disclosed in the drawings, a number of deviations from this construction being possible. Hereinbefore, it was indicated as being possible to have the work piece stationary relatively to the machine frame during the grinding operation and instead to cause the lead unit to guide the grinding tool in the requisite manner. It is also conceivable to impart adjusting movements to the work piece as well as to the grinding tool, the latter being, for instance, mounted in a head stock displaced rectilinearly during the grinding operation, while the work piece performs at the same time the rotary movement required as a complement to the rectilinear movement, in order that the shape of the tooth shall be followed. The guide rail may be replaced by a curve deviating from the rectilinear shape, according to the shape of the edge of the work piece. Nor is the invention tied to the example of embodiment disclosed in the drawings as far as the detail constructions are concerned.

What I claim is:

1. In a grinding machine the combination with a frame, a grinding tool carrying member, a work piece carrying spindle journalled in a movable carrier, a dividing unit comprising a pair of members mounted on said spindle and angularly adjustable with respect to each other, means for coupling said members mechanically in the desired one of a plurality of positions of angular adjustment, and means for clamping one of said members to said spindle, of a lead unit for guiding the rotary movement of said spindle, relatively to the carrier; said lead unit comprising a guide rail mounted in the frame to be set in various angular positions about an axis relatively to said frame, means for clamping said rail in a desired position of angular adjustment two-way motion-transmitting means connecting said rail to the other member of said pair of members and thereby to said spindle when said pair of members are mechanically connected by said coupling means, whereby motion may be transmitted to said spindle upon displacements of said carriage when said guide rail is clamped by said clamping means in angular position with respect to the path of movement of said carriage and alternatively angular adjustment of said guide rail may be effected by rotation of said spindle when said clamping means is released, said motion-transmitting means including a roller engaging said rail and having a neutral position in which its axis coincides with the axis of angular adjustment of said guide rail, and cooperating means

on said carrier and said other member for latching the latter in a preselected zero position of angular adjustment with respect to said spindle corresponding to the neutral position of the motion-transmitting means.

2. In a grinding machine as claimed in claim 1, the provision of a holder for the guide rail displaceable in the longitudinal direction of the frame, mounting means supporting said guide rail for sliding movement, means supporting said mounting means for angular movement on said holder, means for clamping said mounting means to said holder in a desired position of angular adjustment, and of means to lock said guide rail to said mounting means.

3. In a grinding machine, the invention as recited in claim 1, wherein said dividing unit members comprise a carried disk which is the member of said pair which is connected to said guide rail by said two-way motion-transmitting means, and a dividing plate having a series of circumferentially spaced openings, and said latching means comprises a latch slidably supported on said carrier and a latch-receiving opening extending through said dividing plate.

4. In a grinding machine, the invention as recited in claim 1, wherein said dividing unit members comprise a carrier disk and a dividing plate having a series of circumferentially spaced openings, and said coupling means comprises a stop pin mounted on said carrier plate for engagement in the selected opening of said dividing plate.

5. In a grinding machine, the invention as recited in claim 1, wherein said dividing unit members comprise a carrier disk and a dividing plate having a series of circumferentially spaced openings; and wherein said means for transmitting motion to the other member of said pair comprises a gear rotatably mounted on said spindle and having a hub carrying said dividing plate, and a rack bar meshing with said gear, a roller being journalled on said rack bar and seated in said guide rail.



6. In a grinding machine, the invention as recited in claim 1, in combination with means for establishing a desired clearance angle for the surfaces of the work piece, said means comprising a cooperating graduated scale and fiducial mark on said carrier disk and movable carrier.

KARL WILHELM JOSEF HJELMBLAD.


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