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2,388,064

THREAD GRINDER

Filed June 29, 1944

5 Sheets—Sheet 2

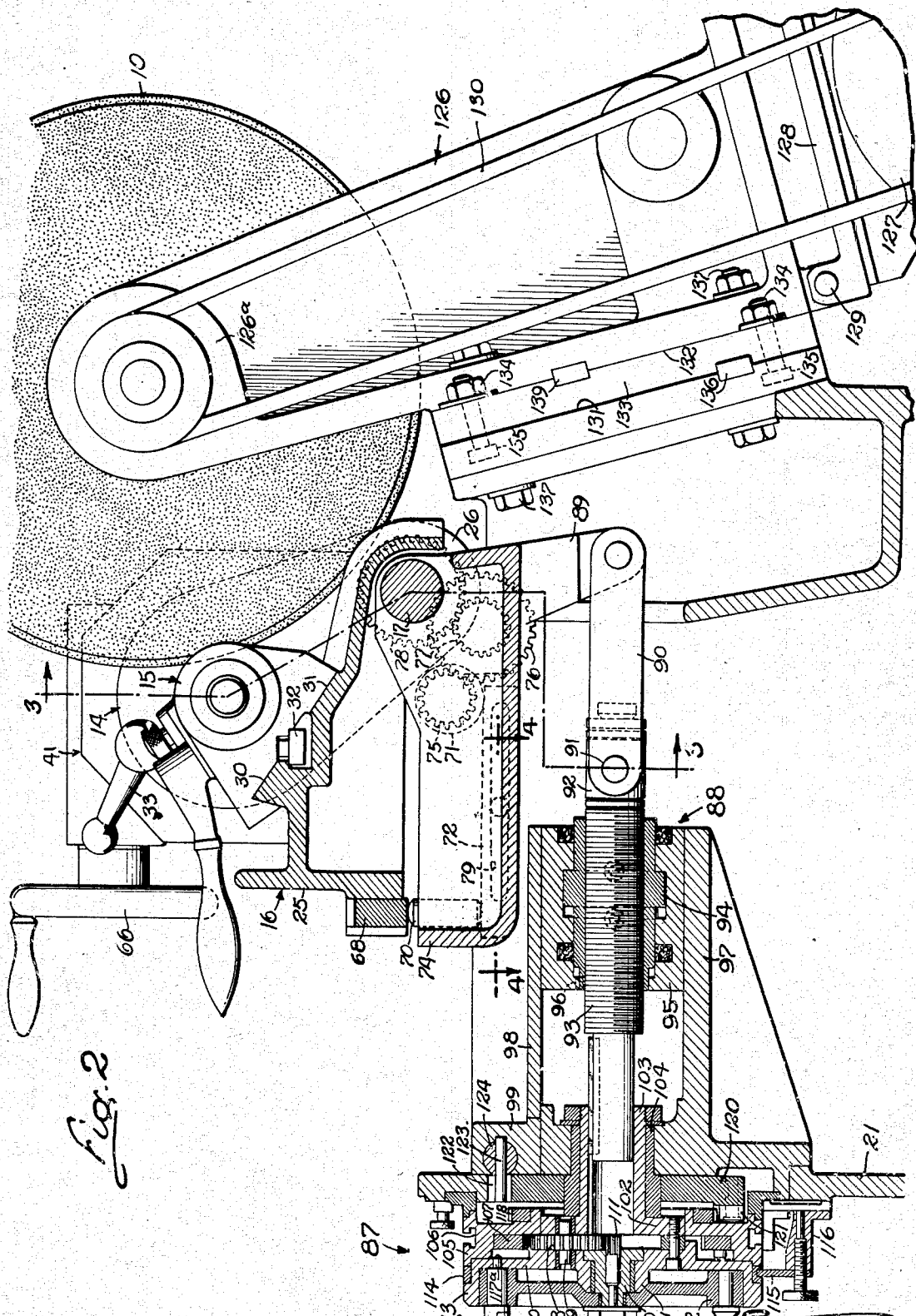


Fig. 2

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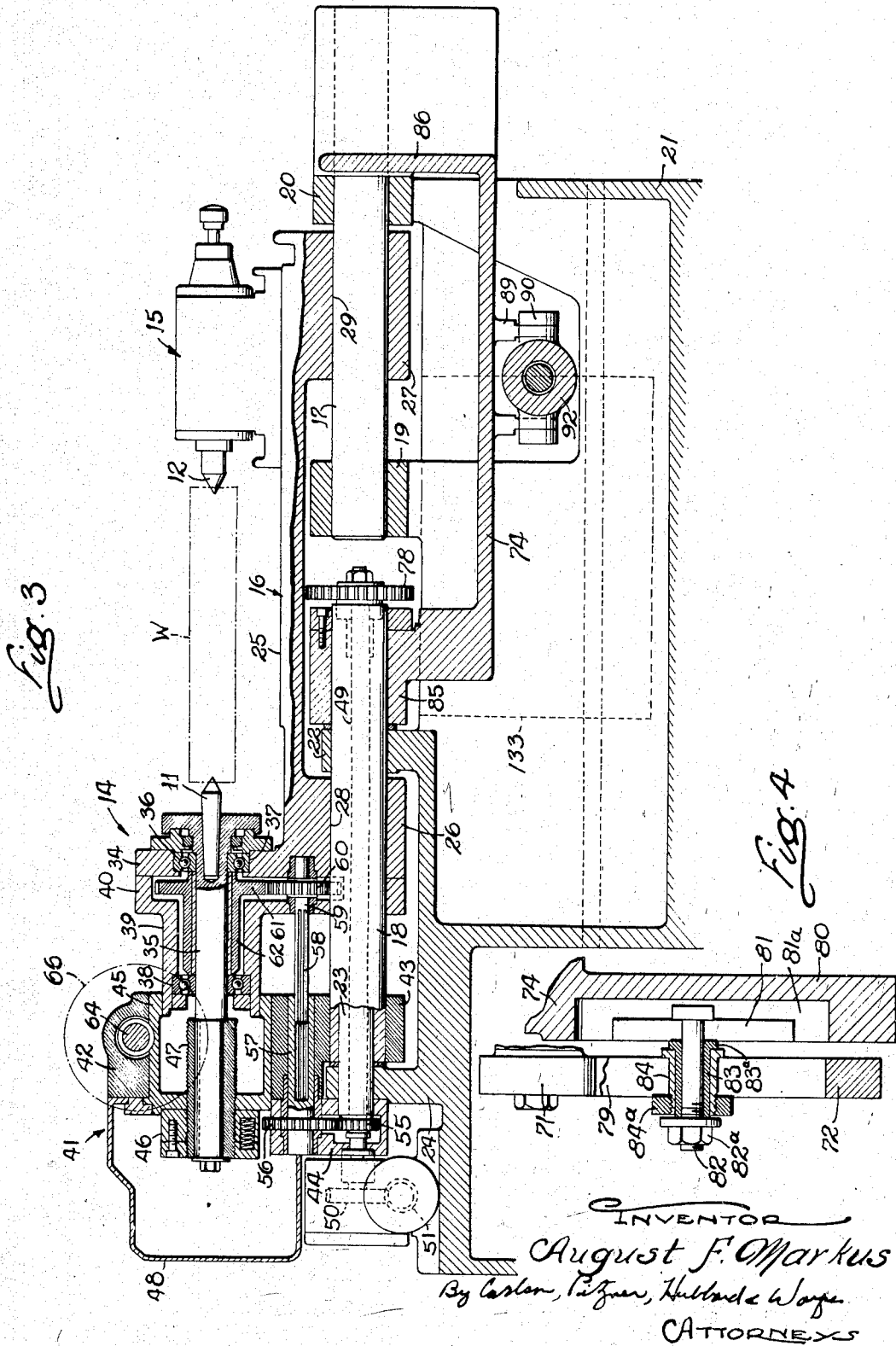


Fig. 3

Fig. 4

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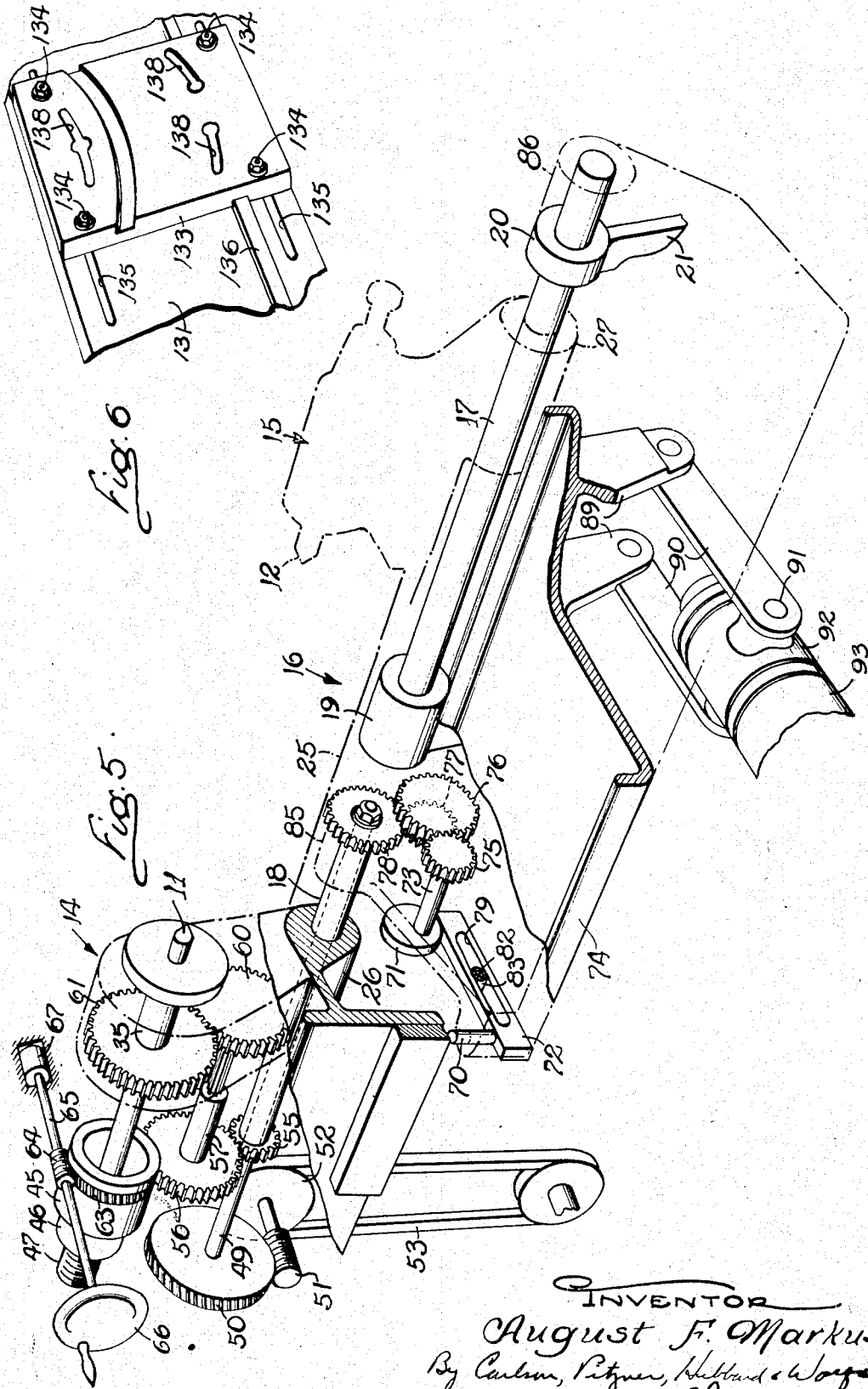


Fig. 6

Fig. 5

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# UNITED STATES PATENT OFFICE

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## THREAD GRINDER

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Application June 29, 1944, Serial No. 542,719

18 Claims. (Cl. 51-94)

The present invention pertains to a novel machine for performing thread grinding operations.

The general aim of the present invention is to provide a thread grinder embodying a novel and simplified combination of elements such as to adapt it especially for production in small sizes while still incorporating various refinements necessary in producing high precision work, the resultant simplification and minimization of size affording not only a low cost machine suited to the quantity production of high precision thread ground parts such as are used, for example, in aircraft, but also one which may be operated with facility by women in view of the small muscular effort involved.

Another object is to provide a machine of the general character indicated which embodies a novel combination of elements by which work is produced rapidly and inexpensively by reason of the rapidity of manipulation of which the machine is capable.

Further objects and advantages of the invention will become apparent as the following description proceeds, taken in connection with the accompanying drawings in which:

Figure 1 is a front elevation of a thread grinding machine embodying the present invention.

Fig. 2 is an enlarged fragmentary sectional view taken from front to rear through the machine substantially along the line 2-2 in Fig. 1.

Fig. 3 is a longitudinal sectional view taken substantially along the line 3-3 in Fig. 2.

Fig. 4 is an enlarged detail sectional view taken substantially along the line 4-4 in Fig. 2.

Fig. 5 is a perspective view of the drive and operating connections for the work supported head, the latter being indicated partially in phantom by broken lines.

Fig. 6 is a fragmentary detail perspective view of the adjustable support for the grinding wheel included in the machine.

Fig. 7 is a fragmentary front elevation of the work support and underlying intermediate support, with the latter partially in section.

Fig. 8 is a fragmentary perspective view of one end portion of the intermediate support.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit

and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawings, the invention has been exemplified therein as embodied in a thread grinder especially adapted for speedy production of high precision thread ground parts. In Fig. 1, the illustrative machine there shown embodies a grinding wheel 10 mounted for rotation about an axis extending generally transversely of the machine and adapted to grind a work piece indicated at W in Fig. 3 and received between centers 11 and 12 of headstock and tailstock 14 and 15, respectively, incorporated in a work supporting head designated generally as 16. Such head 16 is arranged in a manner hereinafter detailed to reciprocate to and fro past the grinding wheel 10 and also to pivot or rock toward and away from the latter about a horizontal axis generally paralleling the wheel's axis of rotation. Reference is made to the axes as being "generally" parallel since provision is made for adjustably skewing the wheel axis slightly out of exact parallelism with the work axis to accommodate various desired helix angles for the threads to be ground. As will appear hereinafter in connection with detailing of the various parts of the exemplary machine shown, provision is made for tilting the work relative to the grinding wheel by several mechanisms and for various purposes, viz: (1) to effect incremental infeeding of the work for size control and to effect subsequent rapid retraction of the work, (2) to effect progressive motion of the work toward or from the wheel in timed relation with the work translation for taper grinding, and (3) to effect periodic motion of the work toward and from the wheel in timed relation with the work rotation, or more often in timed relation with both the work rotation and translation, for use, for example, in relief grinding as in "backing off" or relieving the teeth of thread cutting tools being ground such as taps or thread milling cutters.

Turning now to the matter of the supporting arrangement for the head 16, the same comprises a guide bar of cylindrical exterior shape along which the head is adapted to slide while being free to tilt laterally about the longitudinal axis of the guide bar. In the present instance such guide bar is shown (Fig. 3) as comprised of two sections 17 and 18 disposed in spaced end to end relation with accurate axial alignment. The guide bar section 17 is solid, being fixed in pedestals 19, 20 projecting upwardly from the machine base 21, while the other guide bar section

18 is tubular in form and is fixed intermediate its ends within a pedestal bracket 22 projecting upwardly from the machine base. The opposite or outer end of this guide bar section 18 is supported through the medium of a hollow shaft 23 which is journaled in it and is in turn journaled in a pedestal bracket 24 on the machine base 21.

The work supporting head 16 itself comprises a main frame casting 25 having depending integral feet 26, 27 bored respectively at 28, 29 to receive corresponding ones of the guide bar sections 18 and 17. The head 16 is thus adapted to slide axially of the aligned guide bars 17 and 18 as well as to rock or pivot laterally about their longitudinal axis. The tailstock 15 is of conventional form, being adjustable endwise of the head frame 25 along guide surfaces 30, 31 (Fig. 2) fashioned on the latter and adapted to be releasably clamped in position by a clamping foot 32 operable by a handle 33. The headstock 14, on the other hand, comprises an upstanding wall 34 (Fig. 3) integral with the head frame 25 and bored to receive a work supporting spindle 35 that carries the center 11. An antifriction bearing 36 in a bore 37 supports one end of the spindle 35, whereas the intermediate portion of such spindle is journaled in a second antifriction bearing 38 carried by a tubular extension 39 on a gear housing 40 removably fixed to the wall 34.

As a part of the mechanism for translating the work supporting head 16 in a direction axially of its spindle 11, a second head 41 is provided (Fig. 3), the same being tiltable on the guide rod 18 with the first or main head 16 but restrained against axial movement with the latter along the guide rod. Such second head 41 comprises a main frame casting 42 having a depending lower leg 43 which is bored to receive the cylindrical guide rod or sleeve 18. A block 44 fixed to the lower portion of the frame 42 is disposed at the side of the supporting pedestal 24 opposite the leg 43 and coacts with the latter to restrain the head 41 against movement axially of the guide rod 18. In the upper portion of the head frame 42 a sleeve 45 is revolvably journaled and is open at its righthand end (as viewed in Fig. 3). The tubular extension 39 on the cover plate 40 of the other or main head 16 is telescoped within this open end of the sleeve 45 so that the two head frames are slidably connected for tilting movement in unison while still permitting displacement of the same relative to each other in a direction axially of the guide rod 18.

Axial feed of the main work supporting head 16 is accomplished through the use of coaxing feed screw and nut elements, one of which elements is fixed to the work supporting spindle 35 carried by the head 16 and the other fixed to the companion or non-translating head 41. Such screw and nut elements are desirably mounted for ready replacement since the lead of the thread on the feed or master screw must match that being ground on the work piece. In the present instance a feed nut 46 is clamped to the outer end of the supporting sleeve 45 on the head 41 and threaded on a feed screw 47 keyed to the spindle 35. The nut and its supporting sleeve are normally held stationary, except during adjustment rotation of the same, so that the turning of the feed screw 47 within the nut 46, incident to rotation of the spindle 35, causes the latter to be moved axially in timed relation with its rotation. A removable dust guard 48 encloses the outer end of the head 41.

Rotation of the work spindle 35 and its feed screw 47 is accomplished from a drive shaft 49

(Fig. 3) disposed concentrically with the axis of tilting or pivotal motion of the heads 16, 41 so that the drive connections will remain undisturbed during all tilting movements of the latter. This shaft 49 is journaled within the tubular shaft 23 heretofore mentioned and is driven by a worm gear 50 (Figs. 3 and 6) fixed to its outer end and meshed with a worm 51 which is in turn connected by a pulley 52 and belt 53 with a reversible electric drive motor 54 fixed to the lower portion of the machine base 21 (Fig. 1). A pinion 55 fixed to the drive shaft 49 meshes with a gear 56 carried by a shaft 57 journaled within the block 44. For the drive connection for revolving the spindle 35 the shaft 57 has a sliding spline connection 58 with a shaft 59 journaled in the main head 16 and carrying a gear 60. The latter gear meshes with a second gear 61 rigid with a hub sleeve 62 keyed to the spindle 35. As is customary in machines of the general class here under consideration, provision is desirably made for automatically reversing the drive, as for example by the reversal of the motor 54 at the end of each traverse of the work past the grinding wheel so that the work will reciprocate to and fro past the wheel. Since controls for such purpose are well-known, however, in a variety of forms in the art and since they do not enter into the present invention, detailing here is unnecessary.

Provision is desirably made for lead pickup and backlash compensation. For that purpose a worm wheel 63 (Fig. 5) is fashioned on the exterior of the feed nut supporting sleeve 45 and meshed with a worm 64 carried on a shaft 65 journaled in the head frame 42. Either rotation or axial movement of this shaft 65 correspondingly turns the sleeve 45 and feed nut 46, thereby shifting the work supporting spindle 35 axially. For feed pickup the shaft 65 may be turned by a handwheel 66 located conveniently at the front of the machine (see also Fig. 1), whereas for purposes of backlash compensation fluid pressure is applied (from a suitable source, not shown) alternatively to opposite ends of a piston 67 fixed to the shaft 65 for urging the same in a direction appropriate to take up backlash for the particular direction of rotation selected for the spindle 35.

Progressive tilting motion is imparted to the work supporting head 16 in timed relation with its translation, for use in grinding tapered work through the action of an adjustably inclined cam or taper bar 68 pivoted to this head at 69 and locked in selected positions of angular adjustment, the bar being arranged to ride over an upwardly projecting pin 70 (Figs. 1, 2 and 5), whereas periodic in and out tilting of the head in timed relation with its rotation, for use in relief grinding, is accomplished by the action of a cam 71 (Fig. 5) in periodically tilting a pivoted transverse bar 72 on the outer end of which the pin 70 is mounted (Fig. 5). The cam 71 is of the peripheral type and comprises a disk eccentrically fixed to a shaft 73 journaled in an intermediate supporting member 74 hereinafter more particularly described, and is driven in timed relation with the spindle 35 from the shaft 49 through a set of pick-off gears 75, 76, 77 and 78 arranged to remain in mesh throughout the range of tilting movement of the intermediate support 74. The transverse bar 72 is pivoted on this same intermediate support 74 for tilting motion about a generally centrally located adjustable pivot point.

To afford an adjustable pivotal support for the bar 72 such bar is slotted longitudinally as indicated at 79 (Fig. 4) and a parallel slot is provided at 81 in an upstanding web 80 on the intermediate support 74. Such web is recessed as indicated at 81a at the ends of, and along the rear of, the slot 81 to permit insertion and removal of parts so that the slot 81 is in effect defined between two opposed ribs included in the web 80. A bolt 82 passes through these two slots 79, 81 and has telescoped on it a bushing 83 with an end flange 83a. Tightening of a nut 82a threaded on the bolt 82 thus clamps the web 80 between the opposed head of the bolt and flanged end of the bushing 83 to hold the latter rigidly in a selected position of adjustment along the length of the slot 81. A second bushing 84 is journaled on the first bushing 83 and is releasably clamped to the bar 72 by a nut 84a threaded on such second bushing. To change the location of the pivot point for the bar 72 both the nuts 82a and 84a are loosened and the bushing and bolt assembly slid along the registering slots 79, 81, being retightened at the selected new location.

In some instances, as for example in grinding a tapered tap, it is necessary to use both the taper bar 68 and the relief control cam 71 for simultaneously varying the position of the work piece (through tilting of the head 16) relative to the grinding wheel. In other instances it may be desirable to disable either or both the taper bar 68 and the cam 71. To disable the taper bar it is necessary merely to lock it in such position that its lower edge is exactly horizontal or, in other words, in zero taper position. On the other hand, to disable the cam 71, the nut 84a is loosened, the bar 72 slid outward until the cam 71 no longer contacts it, and the bar locked in such position by a clamping bolt (not shown) passed through the registering slots 79, 81. Variation in the timing of the cam 71 relative to rotations of the work spindle 35 can, of course, be effected at will by substituting appropriately ratioed sets of pick-off gears 75 to 78 to accommodate the requirements of a particular work piece.

The intermediate member 74 heretofore referred to constitutes a tiltable, but non-translatable, support on which the main head 16 rests. The intermediate support 74, being non-translatable, is adapted for attachment to it of suitable actuating means on the base, as will hereinafter appear, for tilting or rocking the same. The head 16, being rested on the intermediate support 74 beneath it, rocks or tilts with the latter but is free to slide lengthwise over it. The other head 41, being connected to the main head 16, of course rocks with the latter. In the present instance the intermediate support 74 is a casting of shelf or apron shape extending generally horizontally beneath the overhanging head 16 (Figs. 2 and 5) and is pivoted by integral upstanding legs 85, 86 (Figs. 3 and 5) on the guide bar 17 coaxially with the head 16.

A size control operating mechanism, designated generally as 87 (Figs. 1 and 2) and located conveniently at the front of the machine, is provided for tilting the intermediate support 74 to shift the work toward the grinding wheel in reducing the work to a desired size. Tilting of the intermediate support 74 for quick retraction of the work is, on the other hand, accomplished by a fluid operator 88 (Fig. 2). Both the mechanism 87 and fluid operator 88 are connected to the rockable intermediate support 74 through a

pair of depending legs 89 on the latter (see also Fig. 5). Such legs are pivoted to the inner end of links 90, the latter being pivoted at their opposite ends on trunnions 91 projecting laterally from a head 92 rotatably mounted on the inner end of an axially movable size control screw 93.

The screw 93 is threaded within a piston 94 (Fig. 2) comprised in the fluid operator 88. Such piston is slidable within a cylinder 95 and keyed at 96 against rotation. The cylinder is, on the other hand, fixed in a body bracket 97 mounted in a recess in the front of the machine base 21, and having a removable cover plate 98 overlying the same, as well as an integral face plate 99 at its outer end. When pressure fluid is supplied (from a suitable source and control valves, not shown) to the left end of the cylinder 95, the piston 94 is thrust to the right, rocking the intermediate support 74 and the head 16 outward away from the grinding wheel 10 to effect a separation of work and tool. Similarly, when pressure fluid is supplied to the opposite or right end of the cylinder 95, the piston 94 is thrust to the left, rocking the intermediate and work supports toward the grinding wheel and bringing the work piece into proximity to the latter. A spline connection between the screw 93 and the connected portion of the operating mechanism 87 affords complete freedom of motion of the screw by the piston without disturbing the connection to such operating mechanism. The fluid operator 88 is used for approaching the work to the grinding wheel preparatory to starting grinding and in withdrawing the work at the completion of the grinding or to interrupt the process. On the other hand, the coating operating mechanism 87 is used to effect the precision controlled, and relatively slow, advances of the work as the grinding progresses requisite to bring the diameter of the work down to an accurately determined size.

It is to be observed that fluid operator 88 does not in any way disturb the setting of the operating mechanism 87 and that, on the other hand, the taper and relief controls heretofore described function automatically, in whatever manner they may be set to do, contemporaneously with, but without interference with, the size control mechanism 87.

The size control mechanism for turning the size control screw 93 may take a variety of forms. In the illustrative arrangement provision is made for revolving the screw 93 to adjust its axial position either manually or by power. As to the manual operating mechanism, a circular indexing plate 100, having an axial hub 101, is bolted concentrically to a peripheral flange 102 on the forward end of a tubular shaft 103 so that the two are rotatable as a unit. The forward end of the shaft extension of the screw 93 is splined for rotation and relative axial movement in the tubular shaft 103, the latter being journaled in a bushing 104 in the body bracket. An annular dog ring 105 formed in the periphery with a T-slot 106 is rotatable on the flange 102 and supports an annular internal ring gear 107. Meshing with the ring gear 107 is a planetary gear 108 mounted for rotation on a stub shaft 109 supported in and between the flange 102 and the index plate 100 to revolve therewith. A stub shaft 110 is confined in and extends through the hub 101 of the index plate 100, and a coaxial sun gear 111 fixed to the inner end thereof meshes with the planetary gear 108.

Fixed on the outer end of the stub shaft 110 is a hand wheel 112. A graduated ring 113 is rigidly

secured to the index plate 100 and rotatably encircles the hand wheel 112. A second graduated ring 114 is rotatably disposed in a notch in the periphery of the ring 113, and is secured against rotation by a key 115 bolted to a lug 116 on the front of the base 21. The hand wheel 112 is adapted to be adjustably connected to the index plate 100 for rotation therewith, or to be disengaged therefrom for independent rotation, by means of a retractable spring detent 117. The detent is adapted for selective engagement with any one of a series of uniformly spaced index apertures 117a (only one of which is shown) in the index plate 100.

When the detent 117 is engaged in one of the apertures in the index plate, the power drive for infeed tilting of the work supporting head 16 is conditioned for operation. In this condition of adjustment, the gears 107, 108, 111 are locked to revolve as a unit, so that rotation of the dog ring 105 will be transmitted directly to the terminal shaft 103 to rotate the feed screw 93. When the spring detent 117 is, on the other hand, disengaged from the index plate 100, the hand wheel 112 is manually rotatable independently of the dog ring 105 to adjust the feed screw 93 for the purpose of rocking the work supporting head 16 into the initial size setting as determined by the diameter of the work piece W. Rotation of the hand wheel 112 acts through the sun gear 111 to turn the planetary gear 108 and cause the latter to roll along the stationary ring gear 107 thereby rotating the terminal shaft 103. The degree of adjustment is indicated by cross graduations on the ring 113 against a reference point on the adjacent ring 114, and fine graduations on the former ring against reference points on the hand wheel 112.

A ratchet mechanism is provided for rotating the dog ring 105 through a predetermined degree upon each reversal of movement of the work supporting head 16. The ratchet mechanism comprises an annular ratchet wheel 118 having external teeth and is rigidly secured to the dog ring 105 for rotation with it. Rotatable on the outer end of a bushing 104 in position against the face plate 99 is a ring 120 having pivoted thereon a pawl 121 engageable with the ratchet wheel 118 to advance the same upon oscillation of the carrier ring 120. Such ring is notched at 122 to receive a pin 123 projecting from a piston 124 slidable endwise within a cylinder 125 (Fig. 1) integral with the face plate 99. By means of suitable controls, not shown since they form no part of the present invention but a variety of forms of which are well-known in the art, pressure fluid is admitted to alternate ends of the cylinder 125 to oscillate the piston 124 in timed relation with the reciprocation of the head 16.

Turning now to the matter of the mounting of the grinding wheel 10 (see Fig. 2), it will be observed that it is journaled in bearings 126a at the upper end of a generally upstanding bracket 126. On the lower end of this same bracket an electric drive motor 127 is carried on a base 128 pivoted to the bracket at 129 so that the weight of the motor will retain taut a belt 130 which connects the same to the grinding wheel.

Provision is made for adjusting the grinding wheel 10 longitudinally of a work piece carried on the work supporting head 16, as well as for skewing the wheel axis in accordance with the helix angle of the thread to be ground. For that purpose flat, accurately machined surfaces 131, 132 are provided in opposed relation on the machine

base 21 and bracket 126, respectively, such surfaces being generally vertical but inclined slightly forward toward the work in this case. A block 133 (see also Fig. 6) having flat, accurately machined, parallel opposite side faces is sandwiched between the surfaces 131, 132. This block is releasably secured to the base 21 by bolts 134 having heads received in T-slots 135 extending longitudinally of the surface 131, the block being accurately guided for adjustment movement axially of the work piece (i. e., longitudinally of the surface 131) by a key 136. The bracket 126 is, in turn, similarly secured to the block 133 by bolts 137 having heads received in T-slots 138 (Fig. 6) which are in this instance arcuate. Adjustment movement of the bracket on the block is accurately guided by an arcuate key 139. The key 139 and slots 138 are centered about a line passing through the axes of the work and grinding wheel. Both lateral and angular adjustment of the grinding wheel 10 can thus be accomplished readily and with precision.

From the foregoing it will be perceived that a grinding machine has been provided incorporating what is, in a structural sense, quite a simple work support, but which affords a high degree of versatility of operation in moving such support relative to the grinding wheel for accomplishing a wide variety of types of precision grinding work. Both manual and automatic tilting of the work support for accurate size control are accommodated (by the mechanism 87) together with quick retraction or approach motion for the work (by the hydraulic operator 88) and progressive adjustable tilt of the work support (by the taper bar 68) in timed relation with the work translation for cutting tapers as well as in and out tilting of the work (by the cam 71) in timed relation with its rotation and translation for relief grinding. Accordingly, the machine is well adapted for grinding threads on either straight or tapered work pieces and for performing relief grinding operations such as are required, for example, in grinding taps. The adjustment and control of these various instrumentalities are simple so that rapid manipulation and high speed production result.

I claim as my invention:

1. A thread grinding machine having, in combination, a base, a rotatively driven grinding wheel mounted on said base, a stationary guide rigid with said base and presenting a cylindrical exterior guide surface positioned with its longitudinal axis substantially paralleling the axis of rotation of said wheel, a work supporting head and an intermediate support disposed, respectively, above and below said guide with the head resting on the intermediate support, both the head and intermediate support being journaled on said guide to swing about the latter's axis, means restraining said intermediate support against movement longitudinally of the guide while leaving the head free to slide therealong, power actuated means for translating said head longitudinally of said guide, and means for adjusting the angle of tilt of said intermediate support to adjust correspondingly the displacement of said head with reference to the grinding wheel.

2. A thread grinding machine having, in combination, a base, a rotatively driven grinding wheel mounted on said base, a stationary guide rigid with said base and presenting a cylindrical exterior guide surface positioned with its longitudinal axis substantially paralleling the axis of rotation of said wheel, a work supporting head

having means thereon slidably embracing said guide to journal the head on the latter for both translatory movement of the head longitudinally of the guide and bodily rocking motion of the head about the axis of the guide toward and from the wheel, an intermediate support also journaled on said guide for tilting movement about the latter's axis but restrained against movement endwise of the guide, said intermediate support being positioned beneath the head with the latter resting on it and slidable therealong, a size control device rotatively mounted on said base, a nut restrained against rotation, and means including a screw threaded in said nut for operatively connecting said size control device to said intermediate support for rocking the latter in response to rotation of said device.

3. A thread grinding machine having, in combination, a base, a rotatively driven grinding wheel mounted on the base, a stationary guide rigid with said base and presenting a cylindrical exterior guide surface positioned with its longitudinal axis substantially paralleling the axis of rotation of said wheel, a work supporting head having means thereon slidably embracing said guide to journal the head on the latter for both translatory movement of the head longitudinally of the guide and bodily rocking motion of the head about the axis of the guide toward and from the wheel, an intermediate support also journaled on said guide for tilting movement about the latter's axis but restrained against movement endwise of the guide, said intermediate support being positioned beneath the head with the latter resting on it and slidable therealong, a size control device rotatively mounted on said base, a cylinder fixed to said base and having a piston slidable therein, a screw threaded axially through said piston and connected at one end to said intermediate support for rocking the latter in response to endwise displacement of the screw effected either by shift of the piston under the influence of pressure fluid applied thereto or by threading of the screw through the piston, and means forming a spline connection between said size control device and said screw.

4. A thread grinding machine having, in combination, a work support, means including an intermediate support beneath said work support sustaining the latter with freedom of endwise sliding movement for the work support with reference to the underlying intermediate support, means mounting both said supports for pivotal motion about a common horizontal axis extending longitudinally of the same and restraining the intermediate support against longitudinal motion while leaving the work support free for such motion, means for adjustably rocking said intermediate support about said axis to thereby alter correspondingly the angle of tilt of said work support with reference to said axis, and a rotatively driven grinding wheel positioned at one side of said work support for operation on a work piece carried by the latter.

5. A thread grinding machine having, in combination, a base, a rotatively driven grinding wheel mounted on the base, horizontal stationary guide means rigid with said base and presenting a cylindrical exterior guide surface positioned with its longitudinal axis substantially paralleling the axis of rotation of said wheel, a head including a frame having a headstock and a tailstock at opposite ends thereof with a work supporting spindle journaled in said headstock, and means including depending feet on said

frame located respectively beneath said headstock and tailstock and slidably embracing said guide to journal the head on the latter for both translatory movement of the head longitudinally of the guide and bodily swinging motion of the head about the axis of the guide toward and from the wheel.

6. A thread grinding machine having, in combination, a base, a rotatively driven grinding wheel mounted on the base, a stationary guide rigid with said base and presenting a cylindrical exterior guide surface positioned with its longitudinal axis substantially paralleling the axis of rotation of said wheel, a head having a work supporting spindle journaled therein, means on said head slidably embracing said guide to journal the head on the latter for both translatory movement of the head longitudinally of the guide and bodily rocking motion of the head about the axis of the guide toward and from the wheel, a drive motor on said base, and a drive connection from said motor and including a rotatable element concentric with said guide axis for both rotating said spindle and translating said head.

7. In a thread grinding machine, the combination of a base having a guide bar rigidly mounted thereon, first and second heads journaled on said guide for bodily tilting motion thereof about the latter's longitudinal axis, means restraining said first head against movement axially of the guide bar, the second head being slidable axially along the bar relative to the first head, slidable guide means joining said heads together in all positions of displacement of the second head axially of the first-mentioned guide to retain said heads in coincidence of angular adjustment therefor about the axis of said bar, means including coacting screw and nut elements fixed to respective ones of said heads for feeding the second head relative to the first in a direction endwise of the bar, a rotatable work spindle journaled in said second head with its axis eccentric to but substantially paralleling said bar, and a grinding wheel positioned alongside said work spindle for engagement with a work piece carried by said spindle.

8. In a thread grinding machine, the combination of a base having an elongated guide rigidly mounted thereon, first and second heads journaled on said guide for bodily tilting motion thereof about the latter's longitudinal axis, means restraining said first head against movement axially of said guide, the second head being slidable axially along said guide relative to the first head, said first head having an opening therein and a feed nut mounted thereon in alignment with said opening, a rotatable work spindle journaled in said second head with its axis eccentric to but substantially paralleling said guide, said spindle having a feed screw fixed thereto and threaded in said nut, a tubular projection rigid with said second head enclosing the spindle and slidably telescoped within the opening in said first head to retain said heads in coincidence of angular adjustment about the axis of said guide, power means for rotating said spindle and feed screw, and a grinding wheel positioned alongside said work spindle for engagement with a work piece carried by said spindle.

9. In a thread grinding machine, the combination of a base having a guide rigidly mounted thereon, first and second heads journaled on said guide for bodily tilting motion thereof about the latter's longitudinal axis, means restraining said first head against movement axially of said guide,

the second head being slidable axially along said guide relative to the first head, said first head having a sleeve journaled therein with an open end presented toward said second head, a feed nut fixed to the end of said sleeve remote from said second head and concentric with said sleeve, a rotatable work spindle journaled in said second head with its axis eccentric to but substantially paralleling said guide, said spindle having a feed screw fixed thereto projecting through said sleeve and threaded in said nut, a tubular projection rigid with said second head surrounding said spindle and slidably telescoped within said sleeve to retain said heads in coincidence of angular adjustment about the axis of said guide, power means for rotating said spindle and screw, means for adjustably turning said sleeve to control the lead pick-up, and a grinding wheel positioned alongside said work spindle for engagement with a work piece carried by said spindle.

10. A thread grinding machine having, in combination, a base, an intermediate support mounted on said base for rocking motion about a horizontal axis, a work support rested on said intermediate support for sliding motion relative to the latter in a direction paralleling said axis and mounted for pivotal motion about the same horizontal axis as said intermediate support, a rotatively driven grinding wheel mounted on said base alongside said work support, means for adjusting the angle of tilt of said intermediate support to tilt the work support correspondingly toward or away from the grinding wheel, and means including adjustable engaging elements carried respectively by said intermediate support and said work support for progressively tilting the latter about said axis relative to the intermediate support in the course of sliding motion of said work support along the intermediate support.

11. A thread grinding machine having, in combination, a base, an intermediate support mounted on said base for rocking motion about a horizontal axis, a head having a work supporting spindle journaled therein, said head being rested on said intermediate support for sliding motion relative to the latter in a direction paralleling said axis, means connecting said head to said base for tilting motion of the head with said intermediate support about said axis, power means for rotating said spindle and translating said head in timed relation, a rotatively driven grinding wheel mounted on said base alongside said work support, means for adjusting the angle of tilt of said intermediate support to tilt the head and its work supporting spindle correspondingly toward or away from the grinding wheel, and means including a cam driven by said power means for progressively tilting said head about said axis relative to the intermediate support in timed relation with the rotation of said spindle.

12. A thread grinding machine having, in combination, a base, an intermediate support mounted on said base for rocking motion about a horizontal axis, a head having a work supporting spindle journaled therein, said head being rested on said intermediate support for sliding motion relative to the latter in a direction paralleling said axis, means connecting said head to said base for tilting motion of the head with said intermediate support about said axis, power means for rotating said spindle and translating said head in timed relation, a rotatively driven grinding wheel mounted on said base alongside said work support, means for adjusting the angle of tilt of said intermediate support to tilt the head and its work

supporting spindle correspondingly toward or away from the grinding wheel, a taper bar extending longitudinally of said head and adapted to be locked thereon in selected positions of inclination, a rocker bar pivoted intermediate its ends on said intermediate support and disposed generally transversely to said taper bar with one end underlying the latter, means for slidably sustaining said taper bar from said one end of said rocker bar, a rotatable cam journaled on said intermediate member and arranged to contact the opposite end of said rocker bar for oscillating the latter about its pivot to raise and lower said head in accordance with the movement of said rocker bar, and means for connecting said cam in driven relation with said power means for rotation of the cam in timed relation with the rotation of said spindle.

13. A thread grinding machine having, in combination, a base, a work support having a work supporting spindle thereon, means mounting said work support on said base for rocking motion about a horizontal axis paralleling said spindle and for translation in a direction paralleling such axis, said base presenting a generally upright planar surface paralleling said axis, a grinding wheel disposed alongside said work support in position for the support to rock toward and away from the same, a mounting bracket for said wheel presenting a surface opposed to said surface on the base, a flat block interposed between said opposed surfaces, and means keying said block for adjustment of the same along said surface on the base in a direction paralleling said axis as well as for angular adjustment of the bracket relative to said block about an axis passing between the axis of said grinding wheel and the axis of said spindle.

14. A thread grinding machine comprising, in combination, a base, a tool head on said base and supporting a rotary grinding wheel, an intermediate support pivotally mounted on said base for rocking motion transversely of the axis of said wheel, a work support pivotally mounted on said base over said intermediate support for rocking motion transversely of said axis and for translation generally longitudinally of said axis, a work spindle mounted in said work support, means for driving said work spindle and translating said work support in positive timed relation and in all pivotal positions of said work support, means on said intermediate support for supporting said work support, means for rocking said support simultaneously as a unit, and means for rocking said work support independently of said intermediate support.

15. A thread grinding machine comprising, in combination, a base, a tool head on said base and supporting a rotary grinding wheel, an intermediate support pivotally mounted on said base for rocking motion transversely of the axis of said wheel, a work support pivotally mounted on said base over said intermediate support for rocking motion transversely of said axis and for translation generally longitudinally of said axis, a work spindle mounted in said work support, means for driving said work spindle and translating said work support in positive timed relation and in all pivotal positions of said work support, means on said intermediate support for supporting said work support, means for rocking said supports simultaneously as a unit, and selectively available means for rocking said work support relative to said intermediate support in

timed relation with the translation of said work support.

16. A thread grinding machine comprising, in combination, a base, a tool head on said base and supporting a rotary grinding wheel, an intermediate support pivotally mounted on said base for rocking motion transversely of the axis of said wheel, a work support pivotally mounted on said base over said intermediate support for rocking motion transversely of said axis and for translation generally longitudinally of said axis, a work spindle mounted in said work support, means for driving said work spindle and translating said work support in positive timed relation and in all pivotal positions of said work support, means on said intermediate support for supporting said work support, means for rocking said support simultaneously as a unit, and means driven in timed relation with the translation of said work support for oscillating the latter relative to said intermediate support.

17. A thread grinding machine comprising, in combination, a base, a tool head on said base and supporting a rotary grinding wheel, an intermediate support pivotally mounted on said base for rocking motion transversely of the axis of said wheel, a work support pivotally mounted on said base over said intermediate support for rocking motion transversely of said axis and for translation generally longitudinally of said axis, a work spindle mounted in said work support, means for driving said work spindle and trans-

lating said work support in positive timed relation and in all pivotal positions of said work support, means on said intermediate support for supporting said work support, means for rocking said support simultaneously as a unit, means for progressively tilting said work support relative to said intermediate support in timed relation with the translation of said work support, and means driven in timed relation with the rotation of said spindle for oscillating said work support relative to said intermediate support.

18. A thread grinding machine comprising, in combination, a base, a tool head on said base and supporting a rotary grinding wheel, an intermediate support pivotally mounted on said base for rocking motion transversely of the axis of said wheel, a work support pivotally mounted on said base over said intermediate support for rocking motion transversely of said axis and for translation generally longitudinally of said axis, a work spindle mounted in said work support, means for driving said work spindle and translating said work support in positive timed relation and in all pivotal positions of said work support, means on said intermediate support for supporting said work support, means operable in timed relation with the reciprocation of said work support for imparting successive increments of rocking movement to said support simultaneously as a unit, and means for rocking said work support relative to said intermediate support.

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