United States Patent

[11] 3,583,102

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[21] Appl. No. **824,236**
[22] Filed **May 13, 1969**
[45] Patented **June 8, 1971**
[73] Assignee **Maschinenfabrik Zuckermann Komm. Ges.**
Vienna, Austria
[32] Priority **May 16, 1968, Dec. 31, 1968**
[33] **Austria**
[31] **A4708/68 and A12721/68**

[54] **APPARATUS FOR THE FINISHING OF CONTOURED WOOD MEMBERS**
10 Claims, 19 Drawing Figs.

[52] **U.S. Cl.** **51/3,** 51/95, 51/96
[51] **Int. Cl.** **B24b 5/26**
[50] **Field of Search** 51/3, 94, 95, 95.1, 96, 97

[56] **References Cited**
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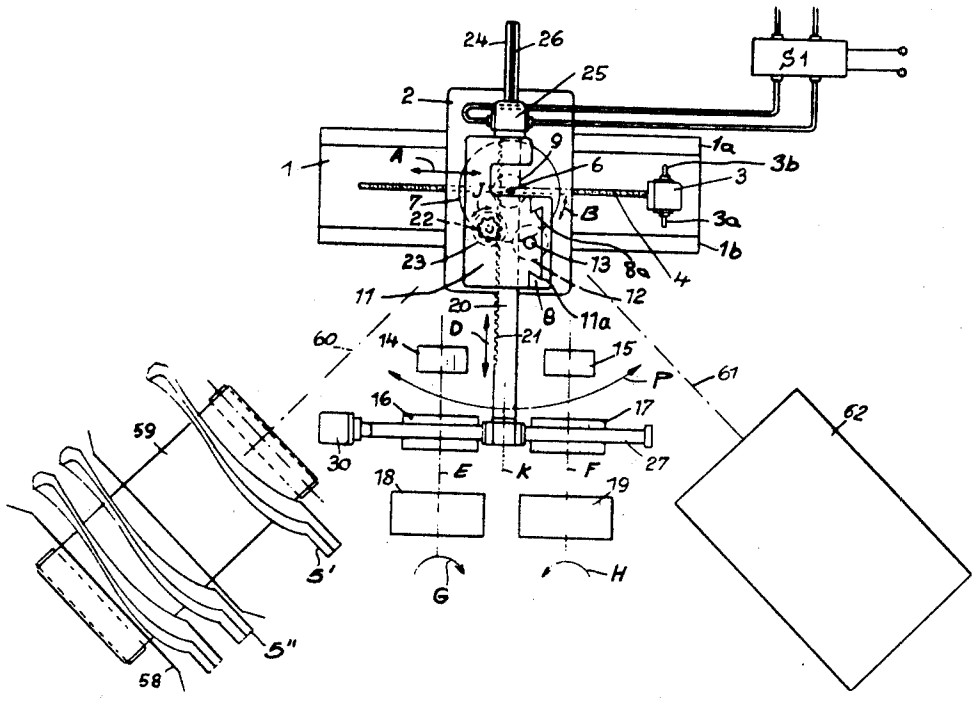
Primary Examiner—Lester M. Swingle
Attorney—Karl F. Ross

ABSTRACT: An apparatus for the abrading of contoured wood members for the finishing and polishing thereof, wherein each longitudinally extending member is held in a yoke and rotated about its longitudinal axis. The yoke, in turn, is rotatable about a horizontal axis at the end of an outrigger arm carrying the yoke, the outrigger arm being swingable in a horizontal plane or a turntable which is shiftable transversely to the axes of rotation of the finishing wheels. The latter are provided alongside a guideway for the tool carriage and are driven in opposite senses and have different diameters and contours such that, in cooperation with hydraulic programmed drives for the swinging movement of the outrigger arm, the vertical movement of the slide carrying the outrigger arm, the horizontal movement of the outrigger arm on the slide, the transverse movement of the slide and its turntable on the carriage, and the rotation of the workpiece about its longitudinal axis, finish the body to the predetermined dimension and configuration.



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SHEET 1 OF 6

Fig.1

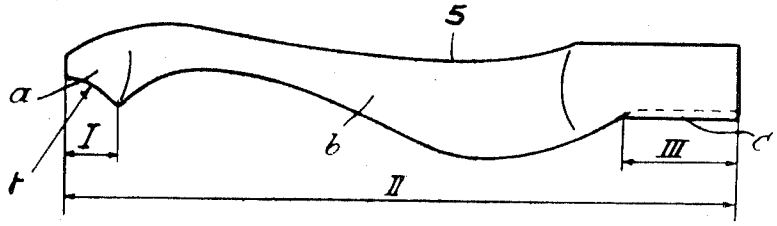


Fig.2

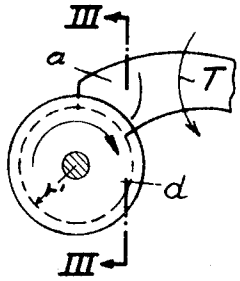


Fig.4

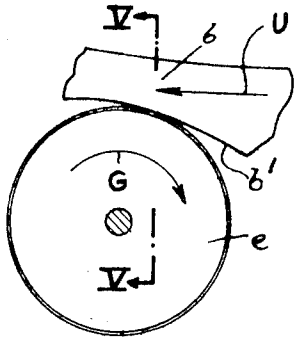


Fig.6

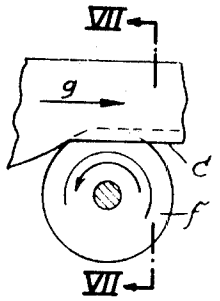


Fig.3

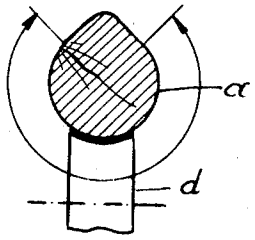


Fig.5

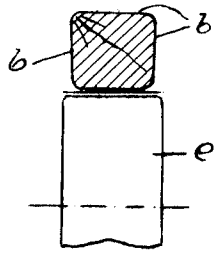
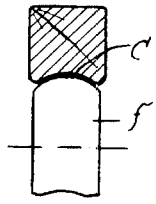


Fig.7



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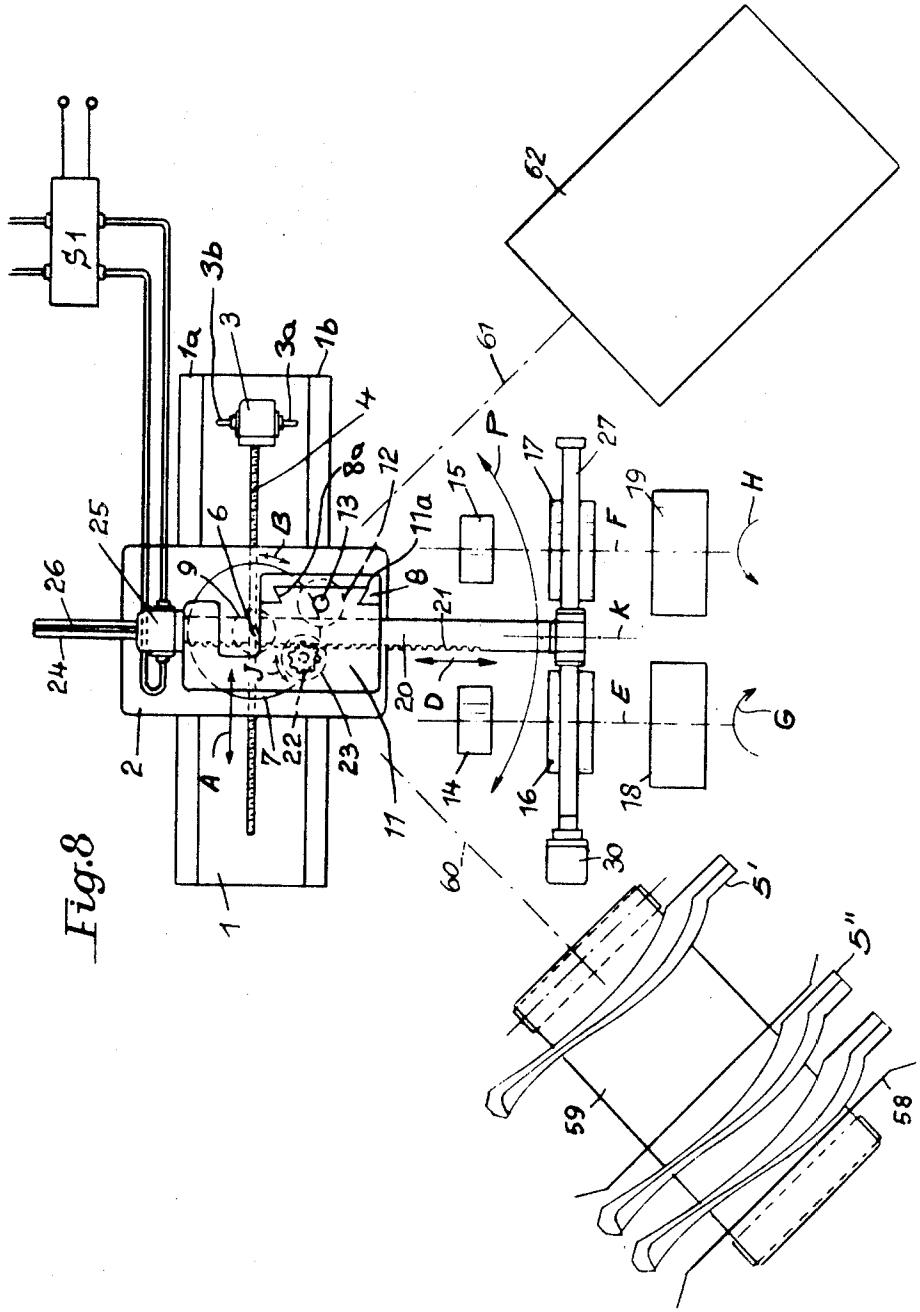

Fig.8

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Fig. 9

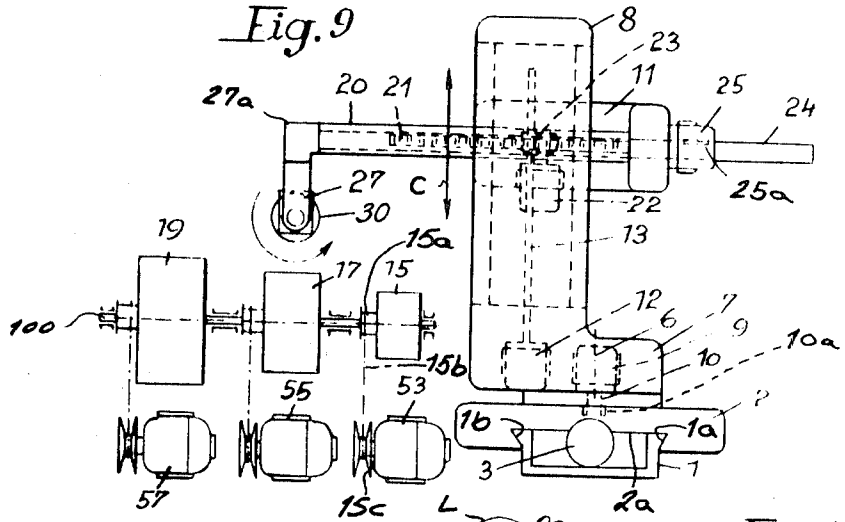


Fig. 10

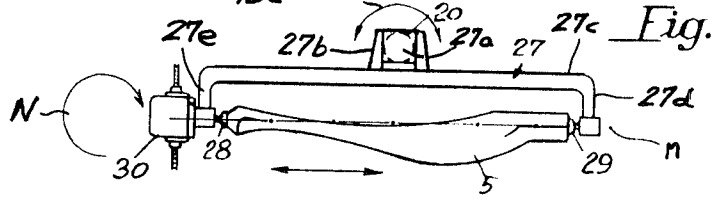
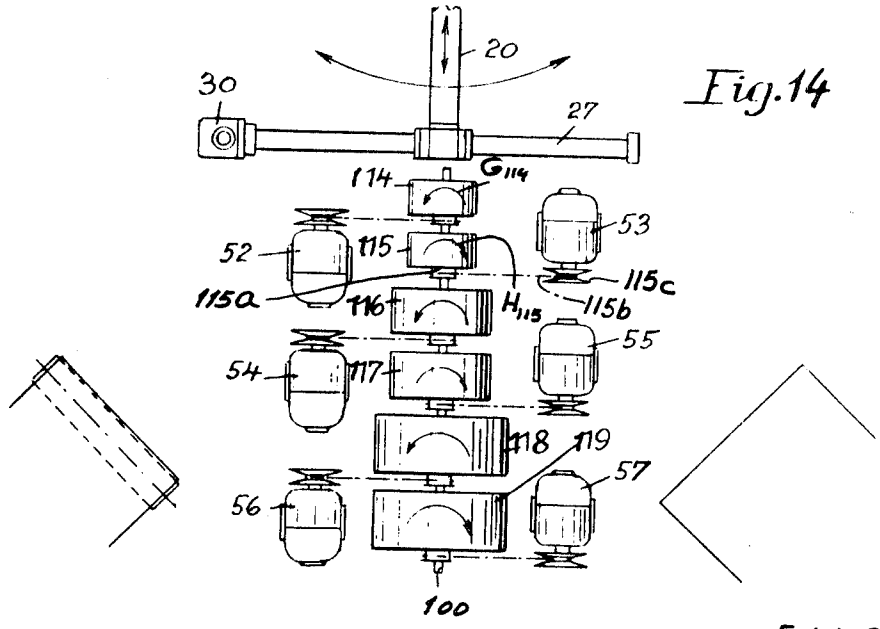


Fig. 14



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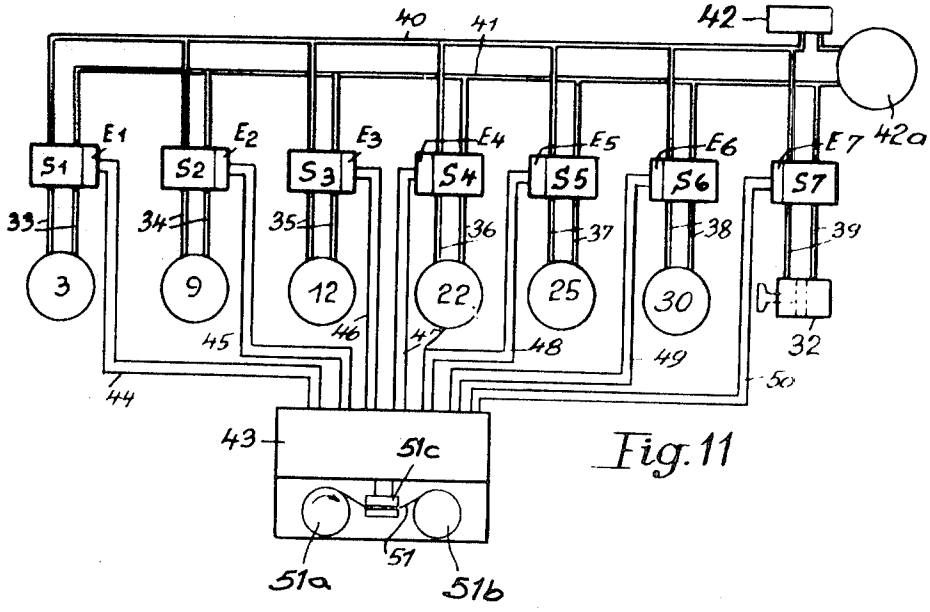

Fig. 11

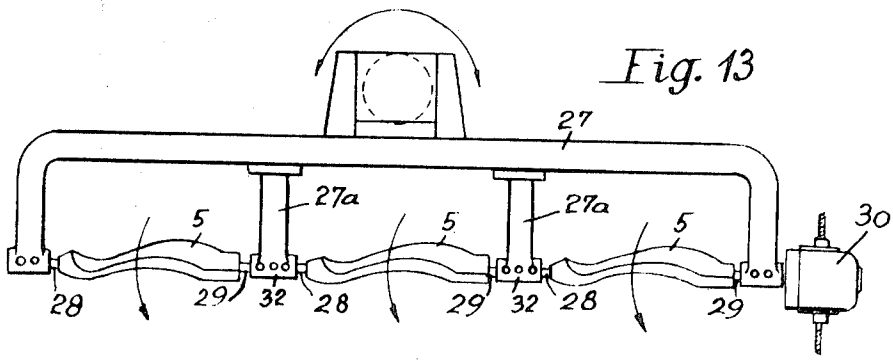

Fig. 13

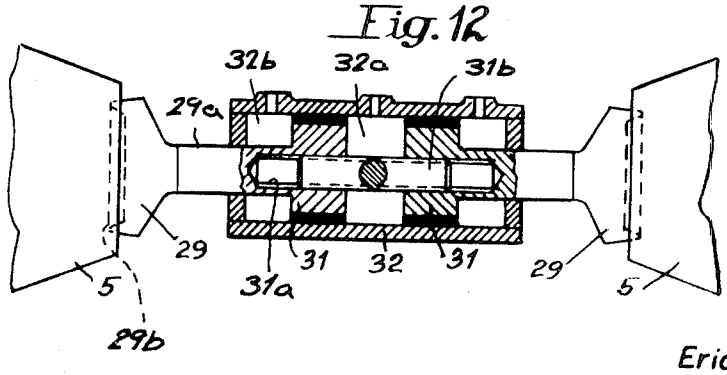

Fig. 12

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FIG. 15

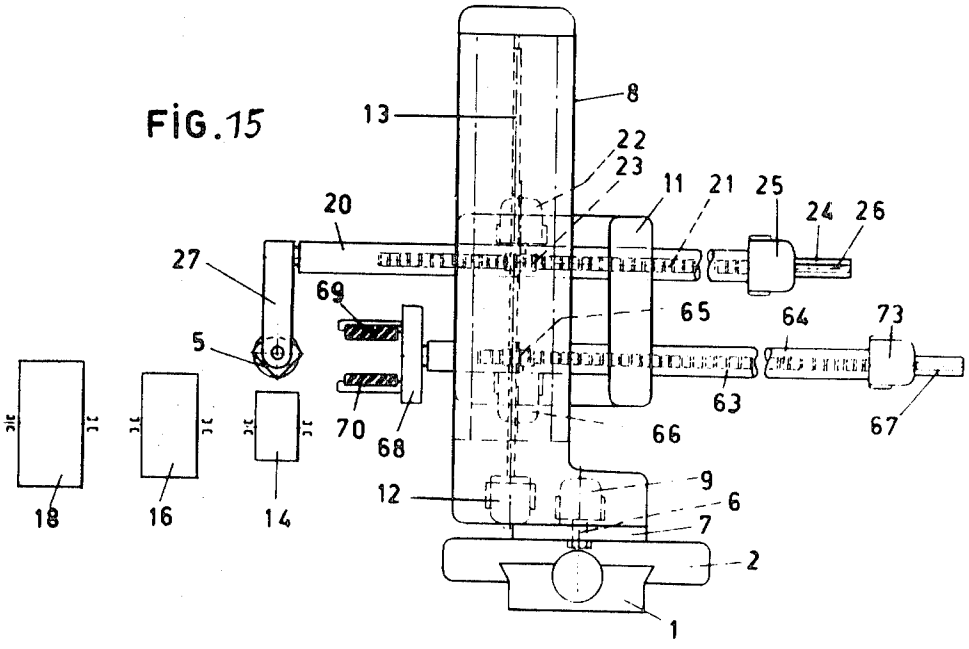
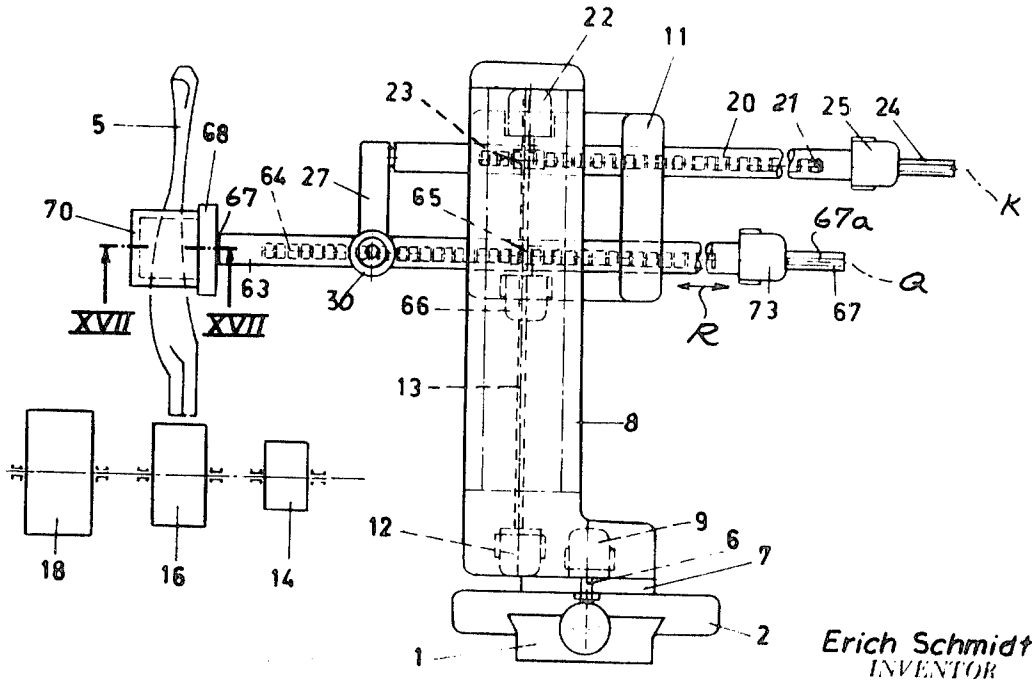


FIG. 16



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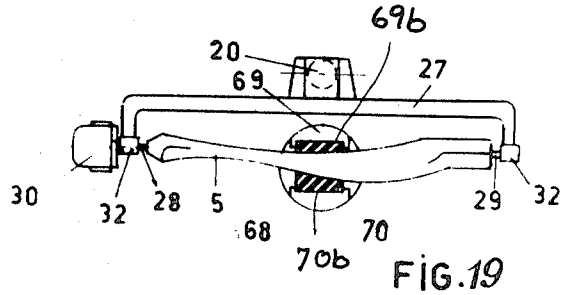

FIG. 19

FIG. 17

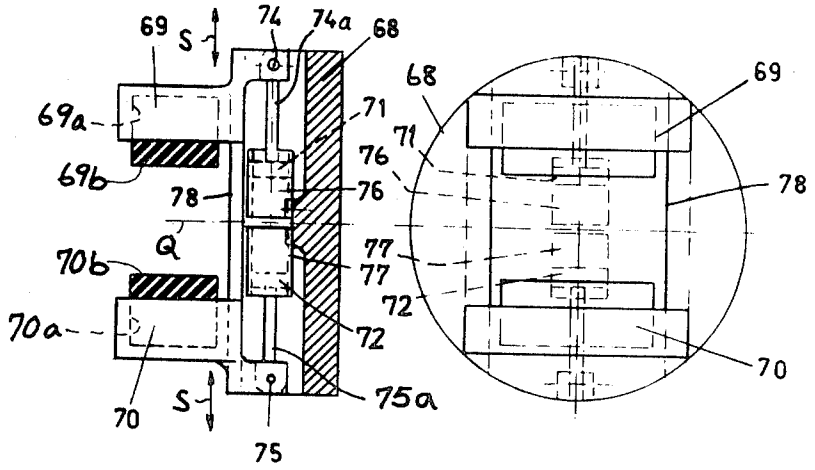

FIG. 18

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APPARATUS FOR THE FINISHING OF CONTOURED WOOD MEMBERS

My present invention relates to an apparatus for the working of elongated contoured wood pieces and, more particularly, to a system for the finishing with abrading wheels (e.g. sanding wheels) or polishing of intricately contoured workpieces of wood, especially furniture legs.

While numerous machines have been proposed to automate shaping processes, existing apparatus for the shaping, grinding, sanding and polishing of intricately contoured workpieces can be classified into a number of categories.

For example, it has been proposed in connection with the shaping of metal bodies by grinding or milling to provide a vertically shiftable slide carrying a pair of grinding wheels on a common shaft which engage the workpiece and produce the desired finish on the surface of the body. The slide is mounted upon a turntable which allows the grinding wheels to shift relative to the machining location. During the working process, the tools are immobilized in this position while the grinding wheels are placed in rotation and the workpiece is displaced therealong. As a practical matter, machines of this type are suitable only to produce relatively linear finished surfaces. They certainly are incapable of machining varying contours on the body and bodies of a wide variety of configurations.

A second type of machines for the shaping of contoured bodies is a copying apparatus having a material removal tool at the end of the copying head and which is controlled by a template or the like. It has also been proposed to use this type of apparatus for the initial shaping and finishing simultaneously, in which case the material removal tool and the abrading or finishing tool are provided one behind the other on the head and controlled by the common template. A system of this character permits a variety of forms to be made but is incapable of readily undergoing transformation from the formation of concave to convex shapes or to the production of shapes with sharply different radii of curvature. As a practical matter, peripheral contouring of elongated workpieces is difficult if not impossible with such prior-art systems.

It is the principal object of the present invention, therefore, to provide an improved machine for the finishing, polishing, abrading or surface treatment of profiled or highly contoured members which may have cross sections of various configurations at different points along the length of the body and may have different transverse contours as well.

Another object of this invention is the provision of an apparatus for the abrading or shaping (sanding or polishing) of furniture legs and like elongated wooden workpieces which yields reproducible products, can be easily controlled, which can be readily switched from one configuration to another, and which allows a much greater variety of shapes to be made than could be made therefore.

These objects and others, which will become apparent hereinafter, are attained in accordance with the present invention by an apparatus in which a longitudinally extending horizontal machine bed is provided with a carriage linearly shiftable thereon, this longitudinal carriage supporting a turntable on which a vertical post or support is mounted, the support in turn being provided with a vertically shiftable slide from which an outrigger is horizontally displaceable transversely to the longitudinal bed.

According to an essential feature of this invention, the elongated workpieces are mounted at an end of the outrigger arm for selective engagement with a plurality of abrading wheels (e.g. sanding wheels) whose spindles and axes of rotation extend horizontally, perpendicular to the longitudinal bed and the direction of movement of the longitudinal carriage thereon.

The wheels, which preferably are provided in pairs of corresponding diameters and contours but opposite senses of rotation, may differ in diameter, profile and sense of rotation and preferably are driven respective drive motors.

The outrigger arm, according to this invention is horizontally shiftable on the vertical slide which, advantageously, allows the outrigger to be raised and lowered relative to the abrading wheels and thus to selectively engage them, the pairs of abrading wheels being spaced apart transversely of the longitudinal bed and the direction of movement of the carriage.

According to a further feature of this invention, the outrigger arm is provided with a workpiece-engaging yoke at its free extremity, the yoke being rotatable about the horizontal axis of this arm. The yoke is provided with clamping means adapted to support the workpiece below the axis of rotation of the yoke and with drive means for rotating the workpiece about its longitudinal axis in a plane perpendicular to the plane of the axis of the outrigger or the rotational axis of its yoke. The clamping means also is designed to engage the workpiece at its ends so that the entire length of the furniture leg may be brought into contact with the respective shaping wheels.

Preferably all of the aforedescribed movements are carried out via hydraulic motors or piston-and-cylinder arrangements individually controlled by respective electrically responsive servo valves from a programming device of the magnetic tape or perforated-band type.

According to another feature of this invention, the apparatus comprises a second outrigger with gripper means engageable with the workpiece carried by the first outrigger at an intermediate location between its ends and rotatable to bring one or both of the end surfaces into contact with a respective abrading or sanding wheel. Thus not only the longitudinal surfaces or workpiece but also the end surfaces may be sanded and finished.

The outrigger arms may be disposed in a vertical plane and may be driven by respective rack and pinion arrangements while forming spindle sleeves for rotary spindles extending through the outrigger arms to rotate the gripper means and the yoke mentioned earlier.

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is an elevational view of an intricately contoured table leg adapted to be finished by the machine of the present invention;

FIG. 2 is a diagrammatic side elevational view illustrating the finishing of the left-hand end of this leg;

FIG. 3 is a section generally along the line III–III of FIG. 2;

FIG. 4 is a view similar to FIG. 2 showing the finishing of an intermediate portion of the table leg;

FIG. 5 is a cross-sectional view taken generally along the line V–V of FIG. 4;

FIG. 6 is a side elevational view showing the contour finishing of the upper end of the table leg of FIG. 1;

FIG. 7 is a section along the line VII–VII of the FIG. 6;

FIG. 8 is a diagrammatic plane view of the finishing machine of the present invention as seen from above;

FIG. 9 is a vertical elevational view, seen from the side, of the machine of FIG. 8, some parts being illustrated diagrammatically;

FIG. 10 is a side view of the workpiece-gripping yoke of the present invention;

FIG. 11 is a diagram of the control system for the machines of FIG. 8—10;

FIG. 12 is an axial cross-sectional view through a fluid-responsive clamping arrangement adapted to grip the workpiece;

FIG. 13 is a view similar to FIG. 10 of a system for the finishing of three workpieces, simultaneously driven and clamped by the device of FIG. 12;

FIG. 14 is a fragmentary plane view, partly in diagrammatic form, of an arrangement of the finishing wheels which differs somewhat from the system in FIGS. 8 and 9;

FIG. 15 is a view similar to FIG. 9 of a machine provided with two outrigger arms according to the invention and capable of finishing end surfaces of the workpieces as well;

FIG. 16 is a view similar to FIG. 15 but showing the machine in another operating position;

FIG. 17 is a cross section, drawn to an enlarged scale of the workpiece-engaging clamp taken along the line XVII–XVII of FIG. 16;

FIG. 18 is an end view of this clamp; and

FIG. 19 is a view similar to FIG. 13, illustrating how the clamp of FIGS. 17 and 18 engages the workpiece.

GENERAL DESCRIPTION (FIGS. 8—10)

The machine illustrates in FIGS. 8—10 comprises a horizontal bed 1 having a set of dovetail V-ways 1*a* and 1*b* slidably mounting a horizontally movable longitudinal carriage 2 whose dovetail recess 2*a* is complementary to the V-ways of the support or bed 1. The support or bed carries, at its right-hand end as seen in FIG. 8, a hydraulic motor 3 whose inlet and outlet sides are represented at 3*a* and 3*b*, the spindle of which is represented at 4 and engages the slide 2 to displace the latter longitudinally along the bed 1 in the horizontal direction represented by the arrow A. The carriage 2, in turn, if formed with a horizontal turntable 7 rotatable about a vertical axis 6 preferably intersecting the axis of the spindle 4 previously mentioned. The rotation of the turntable 7 is represented by arrow B and is effected by a hydraulic motor 9 whose output shaft 10 carries a pinion 10*a* engaging the carriage 2. Consequently, the turntable 7 rotates with the motor 9 upon which it is mounted in the clockwise or counterclockwise sense about the axis 6.

The turntable 7 carries an upright stand or post 8 which is offset from the axis 6 (FIGS. 8 and 10) and is formed with a V-way 8*a* receiving the dovetail 11*a* of a vertically shiftable slide 11. A spindle 13, rising upwardly from the hydraulic motor 12 carried by the turntable 7, threadedly engages the slide 11 to enable the latter to be shifted vertically, i.e. upwardly and downwardly, as represented by the arrow C (FIG. 9). The slide 11 also carries an outrigger arm 20 which is horizontally shiftable in the slide 11 perpendicularly to the axis 6 and, in its working position, transversely to the direction of displacement of the slide 2. The direction of reciprocation of the outrigger arm 20 is represented at D.

Ahead of the bed 1, i.e. laterally thereof in the outward direction of displacement of the outrigger arm 20 in its working position, there is provided, in a common horizontal plane, two rows of coaxially aligned finishing wheels 14, 16, 18, and 15, 17, 19, driven in opposite senses in respective pairs 14, 15, and 16, 17, and 18, 19 by respective motors 3 of which are shown at 53, 55 and 57 in FIG. 9. The wheels which may be sanding, grinding, abrading or polishing wheels of any conventional type, have their common axes E and F extending perpendicularly to the direction of displacement (arrow A) of the carriage 2 and parallel to one another. As shown in FIG. 9, each of the wheels 14—19 may be provided with a pulley, e.g. 15*a*, engaged by a belt 15*b* connected with the driving pulley 15*c* of the respective motor, the pulleys 14—19 being freely rotatable on the respective shafts, e.g. shaft 100 shown in FIG. 9.

The successive wheels 14, 16 and 18 or 15, 17 and 19 of the respective rows may have different contours or may be of different (successively increasing) diameter and can be driven at different rates as will be described in greater detail hereinafter.

The outrigger arm 20 is shiftable, according to the present invention, horizontally in the direction of arrow D parallel to the axes E, F, the shafts of which are rotated in opposite senses, i.e. clockwise and counterclockwise as represented by the arrows G and H in FIG. 8. Thus the outrigger arm 20 determines which of the wheels engages the workpiece.

Outrigger arm 20 is formed as a spindle sleeve 20 and is provided with a rack 21 meshed with a pinion 23 journaled on the slide 11 and driven by a hydraulic motor 22. Rotation of the pinion 23 (arrow J in FIG. 8) advances the outrigger arm 20 toward the wheels 14—19, while rotation in the opposite sense retracts the outrigger.

The longitudinal bore of the outrigger which is formed as a spindle sleeve, as noted earlier, rotatably receives a spindle 24 which is formed with a longitudinal groove 26 receiving a key 25*a* of the rotor of a hydraulic motor 25 coaxially surrounding the spindle 24. The hydraulic motor 25 is carried by the slide 11 and rotates the spindle 24 which, in turn, is designed to swing a downwardly open yoke 27 at the free end of the outrigger 20 angularly about the horizontal axis K thereof in the direction of arrow L.

The forward end 27*a* of the arm 20 thus may be angularly displaceable about the axis K and may be connected with the spindle 24 and driven thereby as represented by the arrow L, while being locked against axial movement with respect to the tooth portion 21 of the outrigger arm 20.

The yoke 27 is connected by a bracket 27*b* with the pivot member 27*a* and comprises a horizontally extending bight 27*c* having a pair of short downwardly extending shanks 27*d* and 27*e* at its end.

A pair of clamping members 28 and 29, rotatable about their common axis M by a hydraulic motor 30, as represented by arrow N, can engage the opposite extremities of the precontoured workpiece 5.

One or both of the members 28, 29 may be fluid displaceable by a mechanism similar to that shown in FIG. 12 of course, the yoke may also be used to retain a number of workpieces as shown for example in FIG. 13.

The workpiece 5, engaged in the yoke 27, can be swung about a horizontal axis (arrow L) to develop any contour that may be required, may be shifted linearly at a horizontal direction transversed to its major dimension (arrow D) to selectively bring the workpiece into contact with the desired finishing wheel or wheels, may be swung arcuately as represented by the arrow P by rotation of the turntable 7, and may be raised or lowered as represented by the arrow C, together with the slide 11.

Movement of the workpiece in horizontal plane selected by the motor 12 parallel to itself as determined by the movement of the outrigger arm 20 in the direction of arrow D and arcuately as represented by the arrows P and L is admissible. The motor 3 also contributes a rotation of the workpiece 5 about its own axis.

The turntable 7 also serves to swing the outrigger arm 20 from its illustrated position in FIG. 8 in the clockwise sense until the outrigger arm 20 assumes the position illustrated by the dot-dash line 60 in which a workpiece 5′, 5″, etc. may be picked up and brought into the operative position. To this end, a magazine diagrammatically shown at 58, dispenses the workpieces 5″ onto an endless conveyor belt 59 which carries the workpieces 5′ to a pickup location at which it can be clamped in the yoke 27. When the outrigger arm 20 is swung beyond the working location in the counterclockwise sense (FIG. 8), it may assume the position illustrated at 61 and deposit its finished workpiece at the discharge station 62.

In FIG. 12, I show a typical arrangement for clamping the workpieces 5 it being noted that only one piston is required in the present system and the splined shaft may be omitted. The clamping device 29 is thus formed on a connecting rod 29*a* of a piston 31 axially shiftable in a cylinder 32 and defining the hydraulic working chambers 32*a* and 32*b* which are connectable to the hydraulic control valve by lines 39 as described in connection with FIG. 11. The piston 31 is internally splined at 31*a* and a splined shaft 31*b* connects the piston 31 with the corresponding piston of the other clamping device or with the hydraulic motor when the member 29 is directly driven. The shaft 31*b* thus acts to transmit torque between the clamping arrangements and allows a single motor to drive a number of workpieces about their common axis M as represented by the arrow N. Teeth 29*b* may be driven into the ends of the workpieces 5 to retain them firmly.

CONTROL SYSTEM (FIG. 11)

In FIG. 11, I have shown a control system which makes use of a programmer generally represented at 43 into which a program has been introduced to instruct the apparatus of FIGS. 8—10 in the proper movements necessary to finish the contoured workpiece.

Typical programmers for this purpose are conventional magnetic tape recorder, perforated-tape machines or even computer memories and readout devices. In each case, however, the important point is that the programmer must be capable of delivering a control signal in accordance with the prerecorded operating sequence, the control signal operating the various valves, servomotors and the like to position the workpiece with respect to the appropriate finishing wheel and to move the workpiece relative to that wheel to attain the desired finish and contour. A typical method of generating the program is to insert a finished body into the yoke 27, connect recording-signal generators to the various spindles and then move the finished body along the tools in the desired sequence and relationships to produce positional outputs which, in turn, are recorded on perforated tape or magnetic tape. The program thus created may control the apparatus to reproduce the finish on the precontoured workpieces. Of course, it is also possible to journal the program analytically or by mathematic treatment. In any case, the control system of the present invention comprises the motors 3, 9, 12, 25 and 30 which are represented in FIG. 11 and are connected by hydraulic lines 33—38 with respective electromagnetically operable servo valves S_1—S_6. The electrical inputs to the servo valves are supplied by the playback unit 43 which is connected via lines 44—49 with these servo valves S_1—S_6.

A further servo valve S_7 is provided between the lines 39 of the clamping cylinder 32 and the hydraulic lines 40 and 41 deriving from the pump 42 and returning to the reservoir 42*a*. The conduit 41 thus constitutes a return duct coming to the servo valves S_1—S_7 while the high pressure line is represented at 40. The servo valves S_1—S_7 are electrically controlled by the coils represented at E_1—E_7. The valves may be of the type described at pages 402—418 of Servomechanism Practice, McGraw-Hill Book Company, Second Edition, N.Y. 1960. The program storage device is here represented as a magnetic tape or perforated band 51 which is drawn off a supply spool 51*a* and delivered to a takeup spool 51*b* in the usual manner while passing a sensing head 51*c* which generates a signal amplified in the control unit 43 to actuate the electromagnetic components E_1—E_7 in the predetermined sequence and thereby operate the respective valves S_1—S_7 and, in turn, control the hydraulic motors 3, 9, 12, 22, 25 and 30 as well as the clamping cylinder 32.

ALIGNED-WHEEL ARRANGEMENT (FIG. 14)

In FIG. 14, I show a slightly different arrangement of the wheels 114—119 which are paired to rotate in opposite senses as represented by the arrows G_{114}, H_{115}, etc. and are carried by a common shaft 100. Here again, each of the wheels 114—119 is provided with a respective driven pulley (e.g. 115*a*) connected by a respective belt 115*b* to the driving pulley 115*c* of the corresponding electric motors 52—57. The three pairs of finishing wheels, all of which have cylindrical abrading surfaces, peripherally engageable with the workpiece 5 are aligned coaxially along the common shaft with mutual axial spacing and may be driven with the different peripheral and angular speeds via suitable speed controls (not shown) for the motors 52—57. The wheels may be rotatable sanding or polishing members preferably air and rubber suspended with an internal pressure close to atmospheric and a thin external wall. Particularly suitable are drums of the type described in the commonly assigned copending application Ser. No. 711,382 filed by myself and Josef Grunwald on Mar. 7, 1968 and entitled "ABRADING TOOL" (now U.S. Pat. No. 3,496,685 dated Feb. 24, 1970). The abrading tool may comprise an inflatable toroidal body of elastomeric material encircled by an abrasive band and carried by a rigid central hub, the outer peripheral wall having a thickness ranging between 0.1 and 2 mm. A pair of stiff discs on the hub flank the toroidal body and extend along the side thereof but terminate short of its outer periphery, the outer peripheral wall of which is highly deformable. In addition, the body may have a relatively thick inner peripheral wall and sidewalls tapering from the thickness of the inner peripheral wall to that of the outer peripheral wall. The body also is generally provided with a nipple for inflating the body to the indicated pressure.

APPARATUS WITH END-FINISHING MEANS (FIGS. 15 and 16)

The apparatus of FIGS. 15 and 16 is generally similar to that of FIGS. 8 and 9 and similar reference numeral are employed except for the distinct parts. The difference between the apparatus of FIGS. 15 and 16 and that of FIGS. 8 and 9 resides in the provision of a further horizontally shiftable outrigger arm 63 carrying a clamping tongs 68 at its forward (left-hand) end. The outrigger arm 63 is spaced below the outrigger arm 20 such that its axis Q is located below the axis K of outrigger arm 20 by a distance equal approximately to the length of the shanks 27*d* and 27*e* of the yoke 27 adapted to retain the workpiece. Outrigger 63 is a spindle sleeve formed with a longitudinal bore in which a spindle 67 is rotatable. The spindle 67 has a keyway 67*a* into which the key of the rotor of hydraulic motor 73 extends. The spindle 67 is anchored to the tongs 68 and may rotate these tongs from the horizontal position illustrated in FIG. 15 into a vertical position shown in FIG. 16. The hydraulic motor is mounted on the rear end of the outrigger 63 and the latter is formed with a rack 64 along its flank corresponding to the rack 21 previously described. A pinion 65, carried by the hydraulic motor on the slide 11 in which outrigger 63 is shiftable (arrow R) in the same vertical plane as outrigger 20, such that the pinion 65 may drive the outrigger 63 in the desired operated sequence. The hydraulic motors 66 and 73 are provided with respective valves (corresponding to the valves S_4 and S_5) which are actuated by the programmer.

The gripper tongs 68 is provided with a pair of clamping jaws (FIGS. 15—19), represented at 69 and 70 and having mutually confronting cup-shaped recesses 69*a* and 70*a* receiving rubber cushions 69*b* and 70*b* designed to prevent marring of the workpiece when it is engaged as shown in FIGS. 18 and 19. To this end, the cushions 69*b* and 70*b* may be contoured (FIG. 19) corresponding to the surfaces of the workpiece 5 engaged thereby. The jaws 69 and 70 are shifted along the guideway in the direction of arrows S, i.e. perpendicularly to the axis Q and transversely to the axis of the workpiece 5. The shifting means includes a pair of cylinders 66 and 67, supplied with fluid via a control valve similar to that shown at S, in FIG. 11, and receive respective pistons 71 and 72 which are connected via piston rods 74*a* and 75*a* with respective articulations 74 and 75 of the jaws 69, 70.

FINISHING OPERATIONS (FIGS. 1—7)

By way of example, in FIGS. 1—7 have shown varying finishing operations which may be carried out upon the workpiece 5 illustrated as a chair leg and treated over the regions I, II and III with three abrading wheels here shown diagrammatically at *d*, *e* and *f*. It will be understood that these wheels may be the wheels 14—19 described in connection with FIGS. 8—19. The wheels *d*, *e* and *f* thus have different profiles, peripheral speed and direction of rotation in accordance with the profile of the workpiece 5, the direction in which the shaping operation is intended to proceed with respect to the movement of the workpiece in the yoke 27 of its outrigger and the configuration to be imparted.

In the zone I, the table leg has the cross section illustrated in FIG. 3, which is circular (over about 270°) and thereafter extends into a triangular profile with a rounded apex. The forming of this area is done by rotating the workpiece 5 about its

axis as represented by arrow T in FIG. 2 while it is in contact with the concave profile of wheel *d*. As is apparent from FIG. 2, the radius of curvature *r* of the end of the leg is determined by the radius *r'* of the wheel and linear movement of the leg during treatment is nonsustained. The rotation of the workpiece and the rotation of the tool are so established relative to one another that the plane of the abrasion wheel at most deviates from the longitudinal axis of the workpiece through an angle of about 1° 40' . Since the periphery of the abrading wheel *d* is yieldable, it conforms readily to the cross section *a* of a workpiece.

The zone II stretches approximately the entire length of the table leg and includes the flat sections of zone I. In this range four planar surfaces *b* are finished and the wheel *e* has a cylindrical profile. Each of the surfaces *b*, however, extends over a different length and with different contours so that a corresponding swing of the outrigger **20** about the axis **6** and corresponding rotation of the spindle **24** is required The workpieces in general move tangentially (arrow U) with respect to the tool *e* which is driven in the direction of arrow G. The wheel *e* has a larger diameter than the wheel *d* inasmuch as the contours of the surface (e.g. *b'*) has a much larger radius of curvature.

The working zone III extends only over the upper end of the leg which is shifted in the direction of arrow *g* to form the concave stretch *c*. The wheel *f* is thus rotated in the counterclockwise sense, has a smaller diameter, and is outwardly convex.

It will thus be apparent that substantially any contours can be produced by suitable selection of the wheels and using the mobility in the workpiece by the devices of FIGS. 8—15.

OPERATION

The preshaped legs 5'' are stacked in the magazine **58** and are fed by the band **59** to the pickup station at the right-hand end of this band as seen in FIG. 8.

The programmer has, at the conclusion of the prior cycle, discharged the finished workpiece carried in the yoke **27** and by hydraulic depressurization of the cylinder (e.g. cylinder **32**) has spread the clamping members **28** and **29** apart.

The hydraulic motor **9** is driven in the clockwise sense (FIG. 8) and the outrigger arm **20** is advance (to the left in FIG. 9) as represented by arrow D until the yoke **27** is positioned directly above the leg 5' at the pickup station. Simultaneously or subsequently, motor **12** is driven to lower the yoke **27** (arrow C) until the clamping member **28** and **29** are precisely aligned axially with the ends of any workpiece 5'.

The programmer **43** then operates valve S_7 to advance the clamping members **28**, **29** to one another and engage the workpiece, hereinafter designated by the reference numeral **5** between them so that the workpiece may be rotated by motor **30**.

Motor **9**, under the control of valve S_2 and the programmer **43**, returns the turntable **7** in the counterclockwise sense until the outrigger **20** is positioned as shown in FIG. 8 in solid lines. Motors **3**, **9**, **12**, **22**, **25** and **30** are then operated in accordance with the desired program and the workpiece brought into contact selectively with the oppositely rotating pairs of similar wheels **14—19**, the opposite rotation of these wheels serving when both are effective to prevent unduly stress upon the outrigger arm.

At the conclusion of the shaping operation, motor **9** is again actuated to swing the outrigger **20** in the counterclockwise sense to the position illustrated in dot-dash lines at **61**, whereupon the slide **11** may be lowered and members **28** and **29** released. The cycle may then begin again.

In the arrangements of FIGS. **15** to **17** the operation is similar, except that the workpiece is released by the outrigger **63** at the conclusion of the finishing operation. Thus when the finishing of the sides of workpiece **5** is completed (FIG. **15**), motor **22** or motor **66** is operated to bring the workpiece **5** into the tongs **68**, whereupon cylinders **71** and **72** may be pressurized to draw the jaws **69** and **70** against the workpiece. After an initial rotation and elevation of the slide **11** (FIG. **16**), the outrigger **63** may be shifted to the left to control the contact between each end of the workpiece and one of the finishing wheels. Thereafter, turntable **7** may be rotated to swing the workpiece to the discharge station, whereupon the tongs **68** are released.

I claim:

1. An apparatus for the treatment of a contoured workpiece, comprising:

a bed defining a generally horizontal, longitudinal guideway;

a carriage shiftable along said guideway;

a turntable mounted on said carriage and rotatable about a generally vertical axis;

an upright support on said turntable;

a slide vertically shiftable on said support;

a generally horizontal outrigger arm shiftable longitudinally on said slide and having an end extending therefrom;

workpiece-engaging means at said end of said arm at a location offset from the axis thereof;

first means for rotating said workpiece-engaging means about said axis of said arm;

second means for rotating said workpiece about an axis thereof relative to said workpiece-engaging means; and

tool means laterally of said guideway including a plurality of tool wheels rotatable about respective axes transverse to said guideway with at least some of said wheels having diameters, rotational senses and profiles different from others of said wheels whereby said arm selectively bring said workpiece into contact with said wheels.

2. The apparatus defined in claim **1** wherein said outrigger arm is a spindle sleeve, said first means including a spindle rotatably received in said sleeve and connected with said workpiece-engaging means for rotating same.

3. The apparatus defined in claim **2** wherein said workpiece-engaging means includes a yoke having a bight connected with said spindle and a pair of shanks, and clamping means on said shanks for gripping an elongated contoured workpiece at its ends.

4. The apparatus defined in claim **3** wherein said slide is provided with a second generally horizontal outrigger arm parallel to the first-mentioned outrigger arm and shiftable longitudinally on said slide, said second outrigger arm having an end, and gripper means at said end of said second arm for engagement with said elongated workpiece intermediate its ends, said gripper means being rotatable about a horizontal axis to bring said ends of said workpiece into engagement with at least one of said tool wheels.

5. The apparatus defined in claim **4** wherein said second outrigger arm is formed as a spindle sleeve, said apparatus further comprising a spindle extending through said second outrigger arm for rotating said gripper means.

6. The apparatus defined in claim **5**, further comprising programming means having an electrical output and storing information representing instructions for movement of said carriage, said turntable, said slide, said outrigger arms, said first means and said second means; said carriage being provided with a first hydraulic motor for longitudinally shifting same along said guideway; said turntable being provided with a second hydraulic motor for rotating said turntable relative to said carriage; said slide being provided with a third hydraulic motor for vertically shifting same on said support; said first outrigger arm being provided with a fourth hydraulic motor for horizontally shifting said first outrigger arm relative to said slide; said first means further comprising a fifth hydraulic motor for rotating the spindle of said first outrigger arm; said second outrigger arm being provided with a sixth hydraulic motor for horizontally shifting said second outrigger arm relatively to said slide; said spindle of said second outrigger arm having an eighth hydraulic motor for rotating said gripper means; said second means including a ninth hydraulic motor mounted on said yoke for rotating said workpiece; said work-

piece-engaging means and said gripper means each including a respective piston-and-cylinder arrangement for selectively gripping and releasing said workpiece; and respective electrically operated hydraulic valves controlled by said programming means and hydraulically connected with each of said motors and with each of said piston-and-cylinder means for shifting said workpiece relatively to said tool means to surface said workpiece.

7. The apparatus defined in claim 6 wherein said wheels are provided in pairs of adjacent wheels of the same diameter, the wheels of each pair having diameters different from the wheels of another pair, the wheels of each pair being rotatable in opposite senses.

8. The apparatus defined in claim 7 wherein all of said wheels have axes lying in a common horizontal plane.

9. The apparatus defined in claim 8 wherein the wheels are arrayed coaxially one behind the other in two horizontal rows transversely spaced from one another, the wheels of each row being rotated in the same sense.

10. The apparatus defined in claim 3, further comprising programming means having an electrical output and storing information representing instructions for movement of said carriage, said turntable, said slide, said outrigger arms, said first means and said second means; said carriage being provided with a first hydraulic motor for longitudinally shifting same along said guide-way; said turntable being provided with a second hydraulic motor for rotating said turntable relative to said carriage; said slide being provided with a third hydraulic motor for vertically shifting same on said support; said outrigger arm being provided with a fourth hydraulic motor for horizontally shifting said outrigger arm relative to said slide; said first means further comprising a fifth hydraulic motor for rotating the spindle of said outrigger arm; said second means including a sixth hydraulic motor mounted on said yoke for rotating said workpiece; said workpiece-engaging means including a piston-and-cylinder arrangement for selectively gripping and releasing said workpiece; and respective electrically operated hydraulic valves controlled by said programming means and hydraulically connected with each of said motors and with each of said piston-and-cylinder means for shifting said workpiece relatively to said tool means to surface said workpiece.