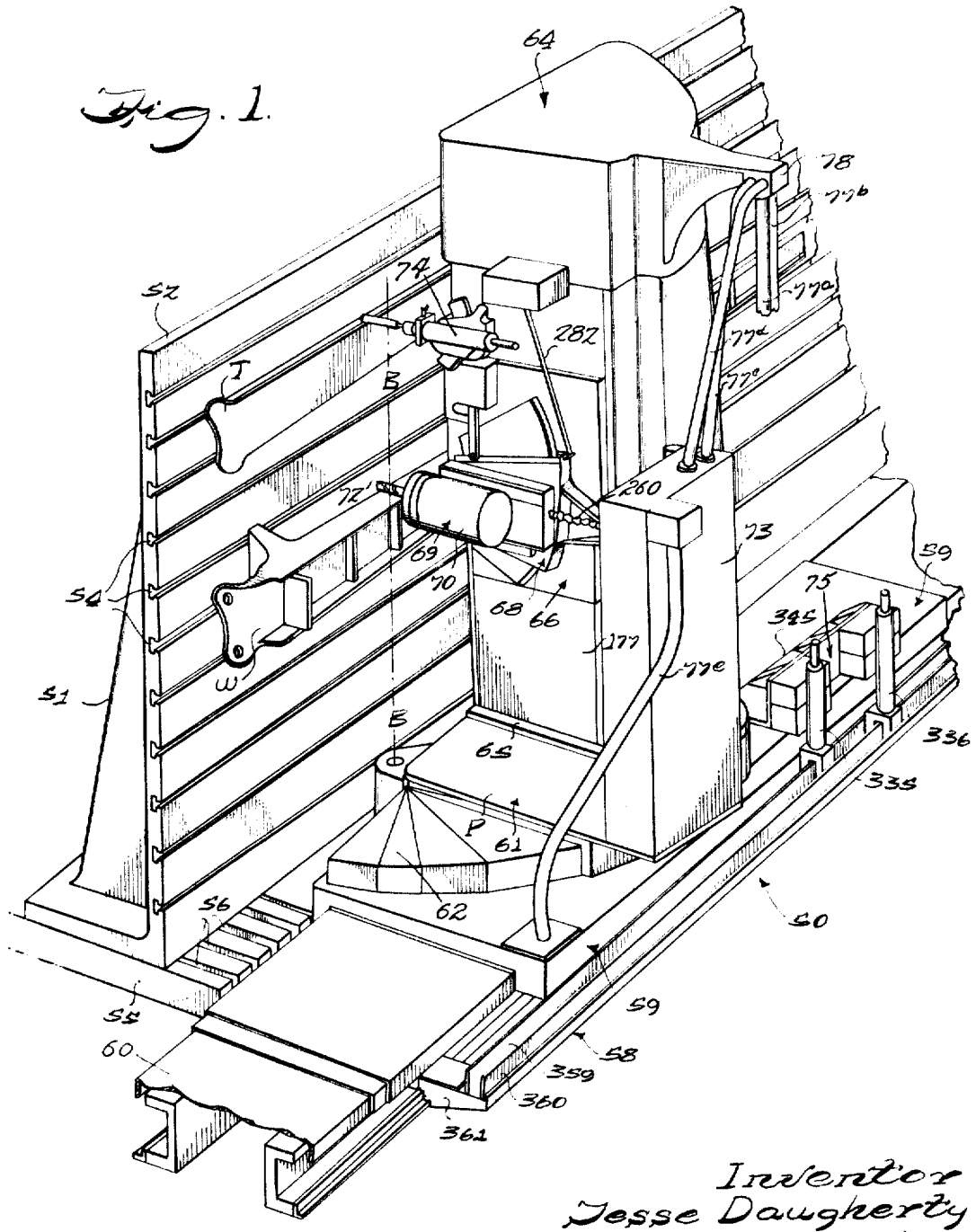
May 21, 1968 J. DAUGHERTY Re. 26,393

HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

Original Filed Nov. 9, 1954 24 Sheets-Sheet 1

Fig. 1.

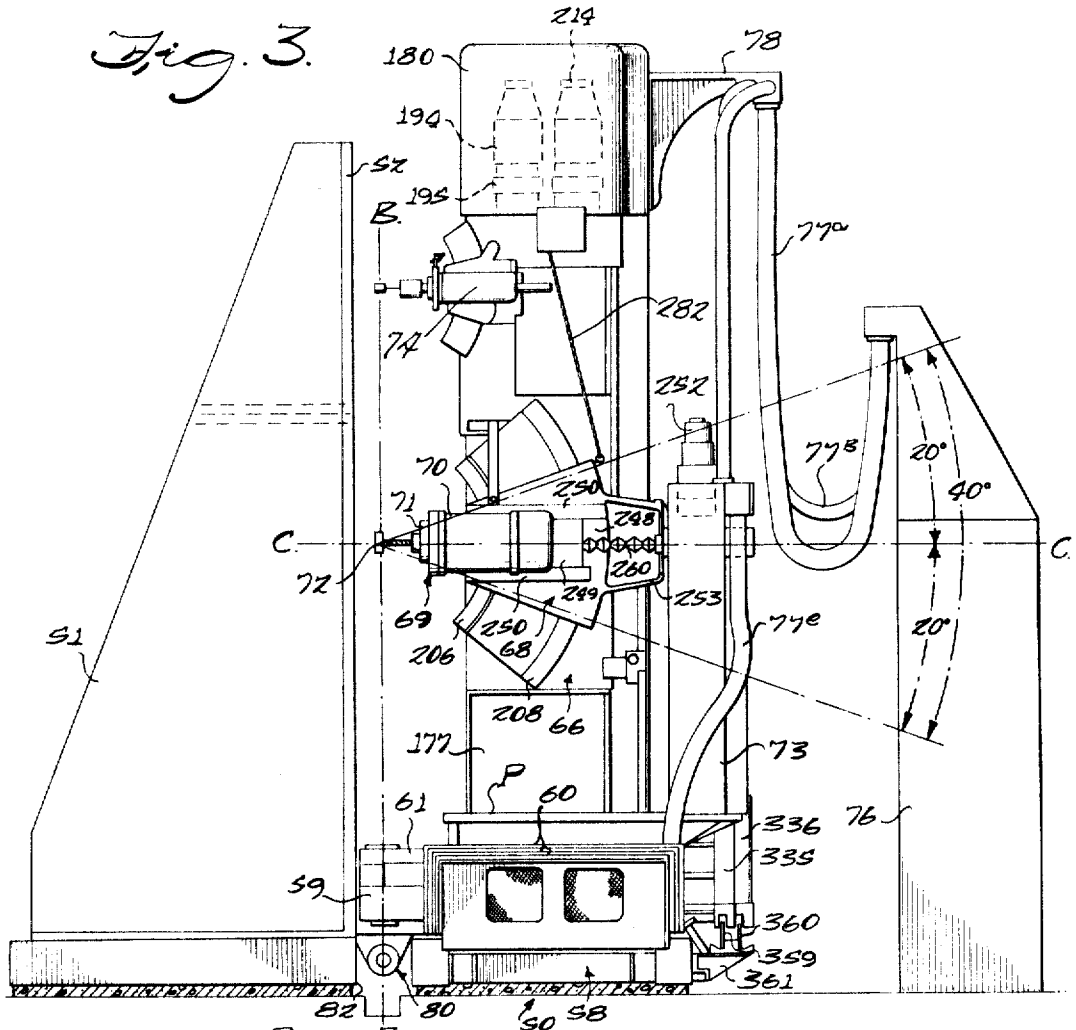


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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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Fig. 3.



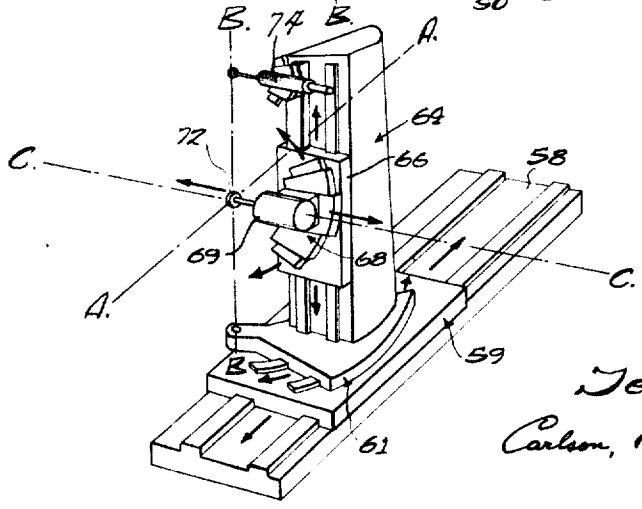


Fig 1A

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

Original Filed Nov. 9, 1954 24 Sheets-Sheet 3

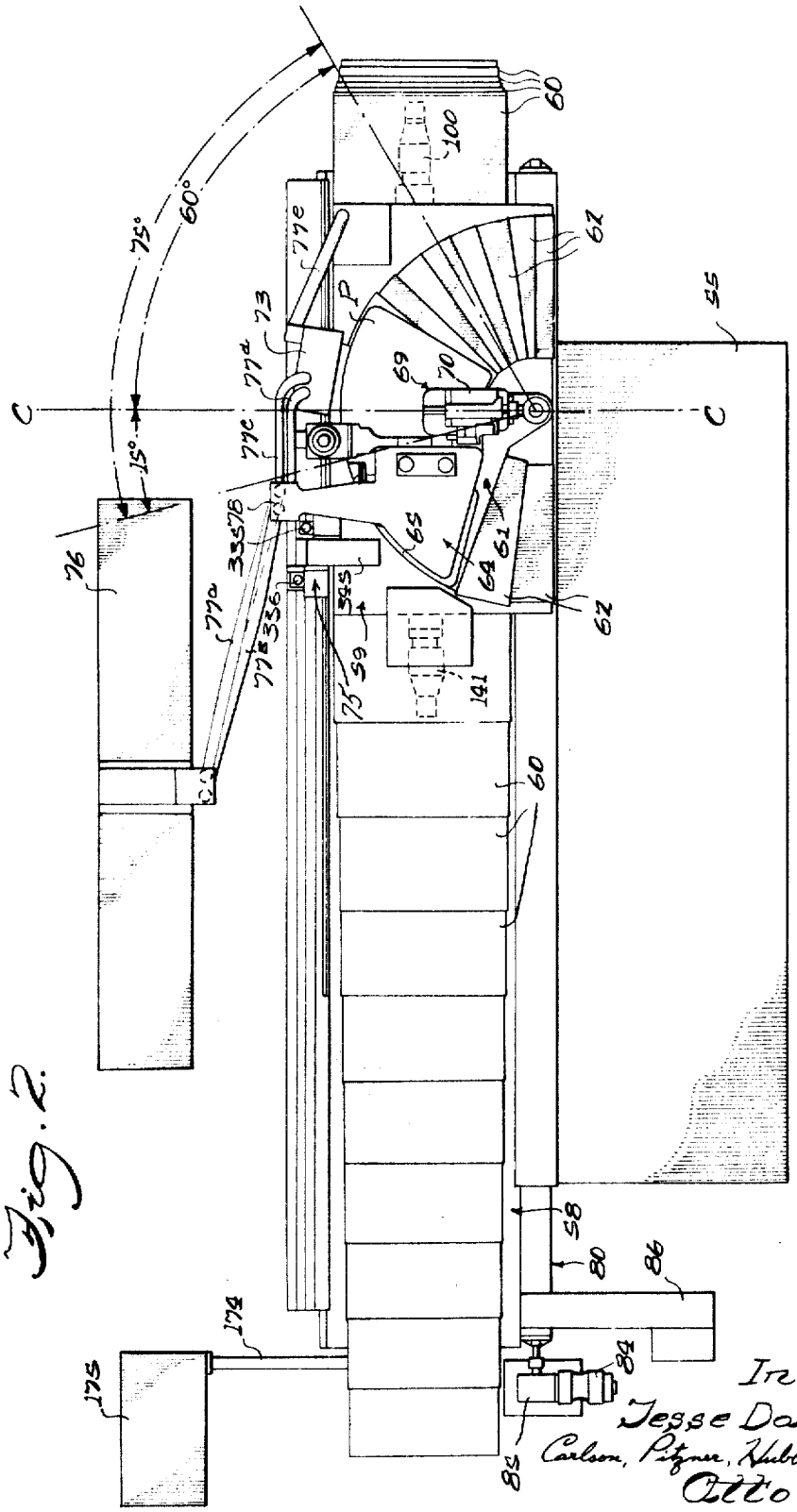


Fig. 2.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

Original Filed Nov. 9, 1954 24 Sheets-Sheet 4

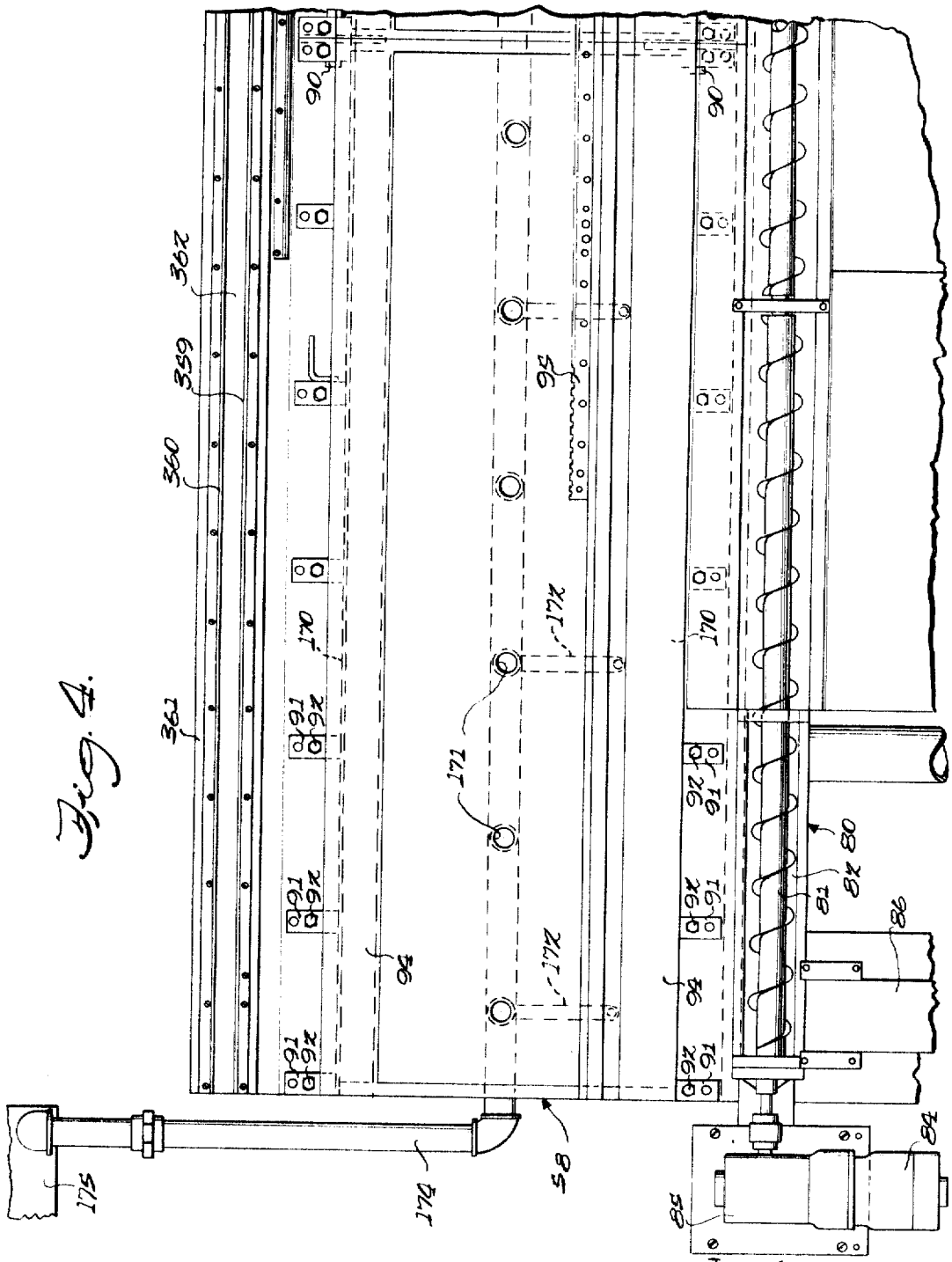


Fig. 4.

Inventor
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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

Original Filed Nov. 9, 1954 24 Sheets-Sheet 5

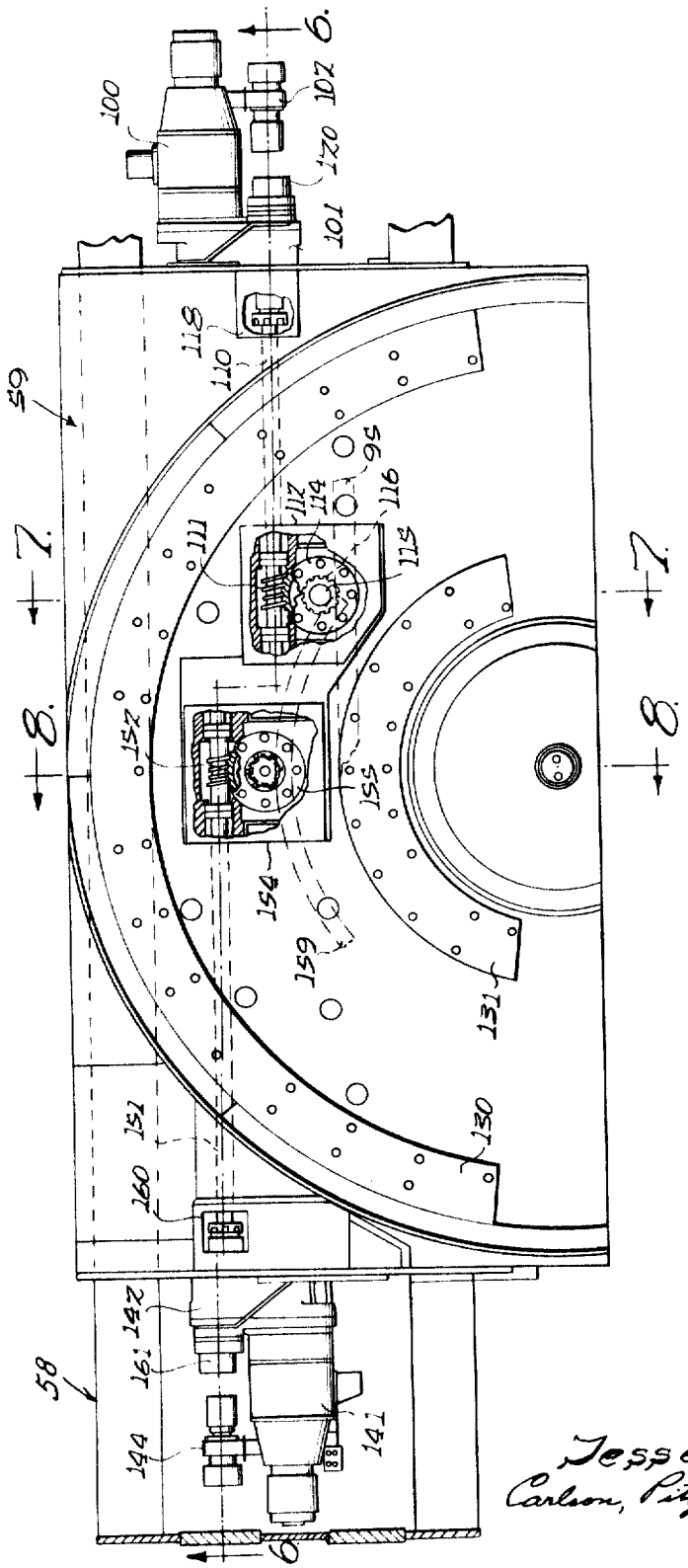


Fig. 5.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

Original Filed Nov. 9, 1954 24 Sheets-Sheet 6

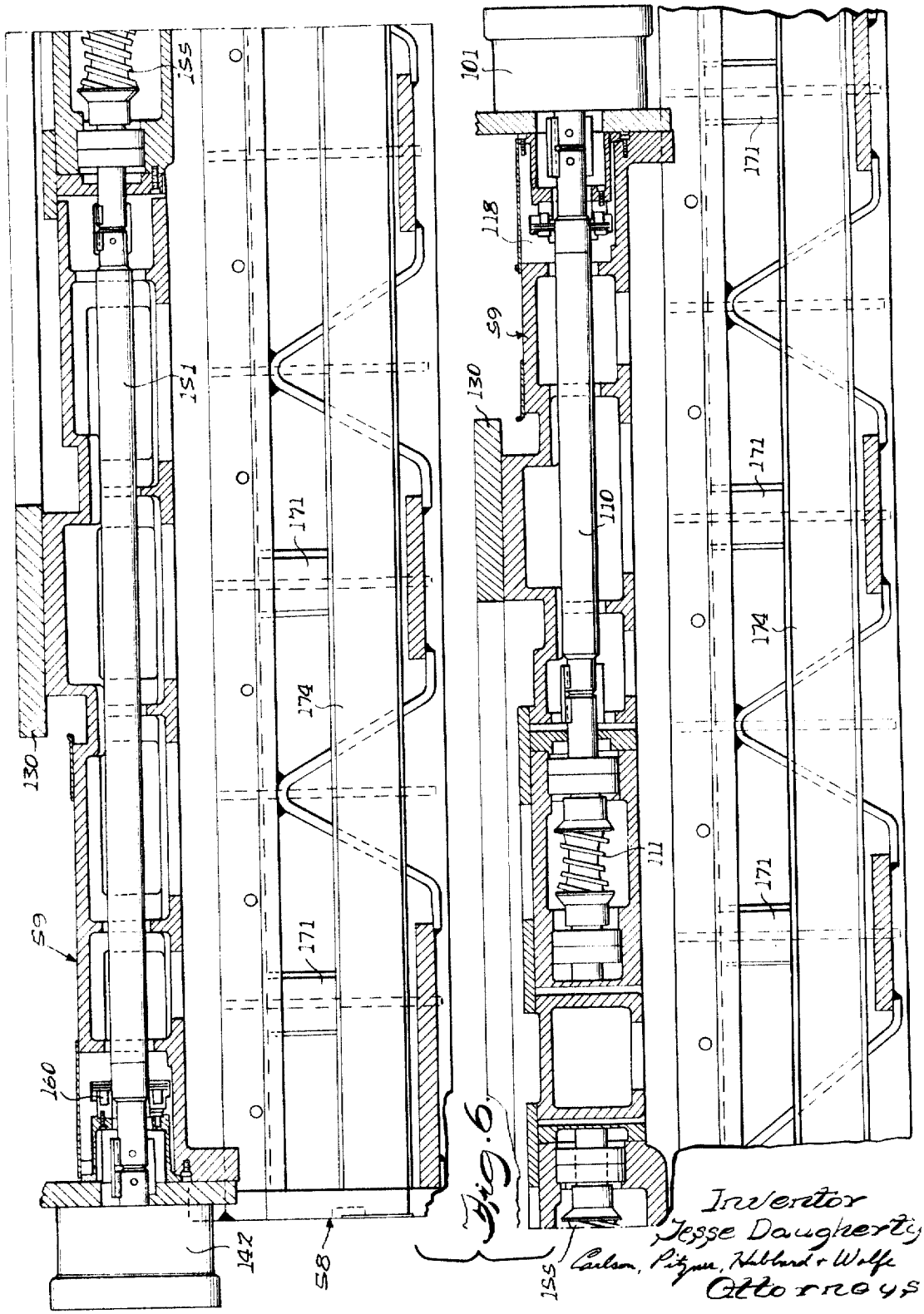


Fig. 6.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

Original Filed Nov. 9, 1954 24 Sheets-Sheet 7

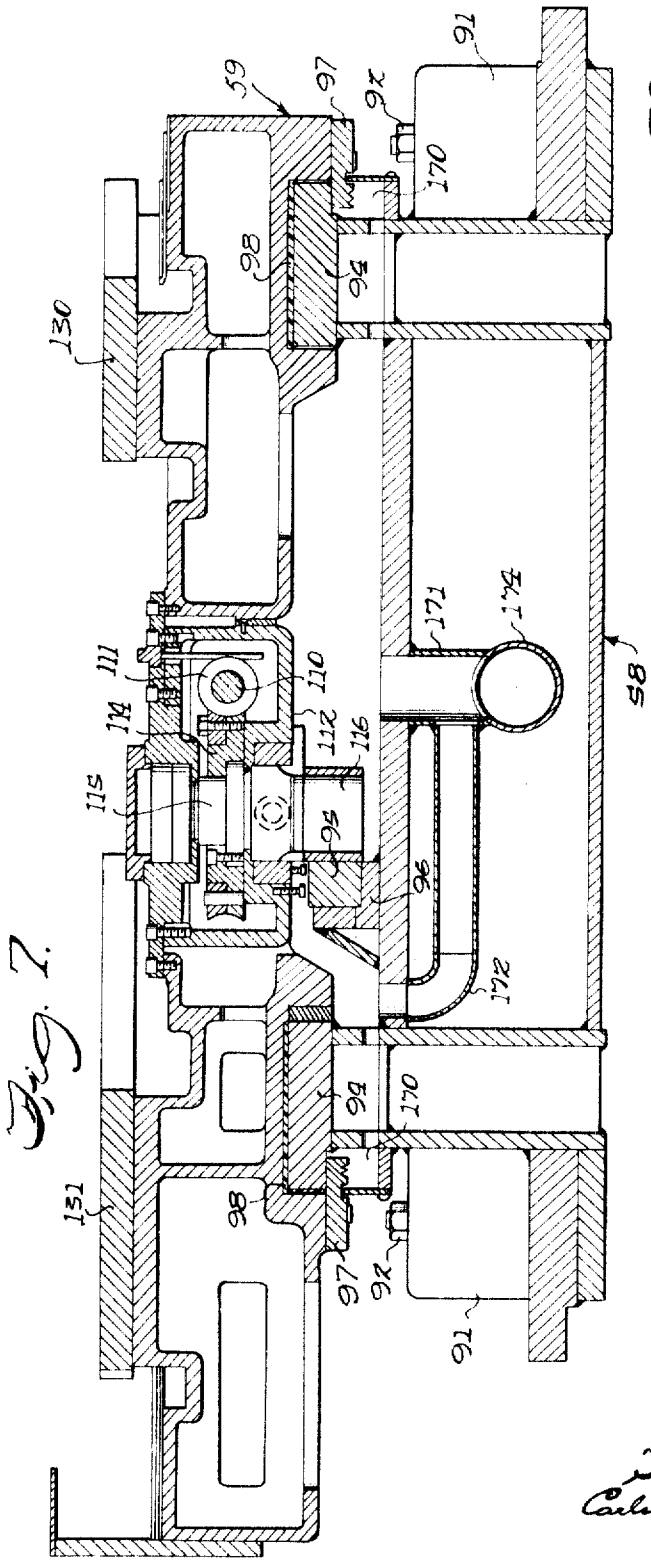


Fig. 7.

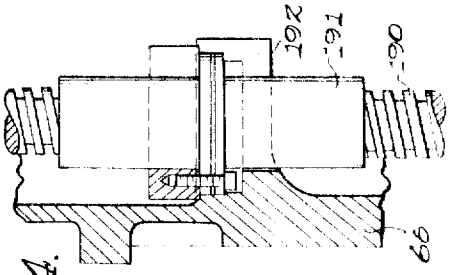


Fig. 14.

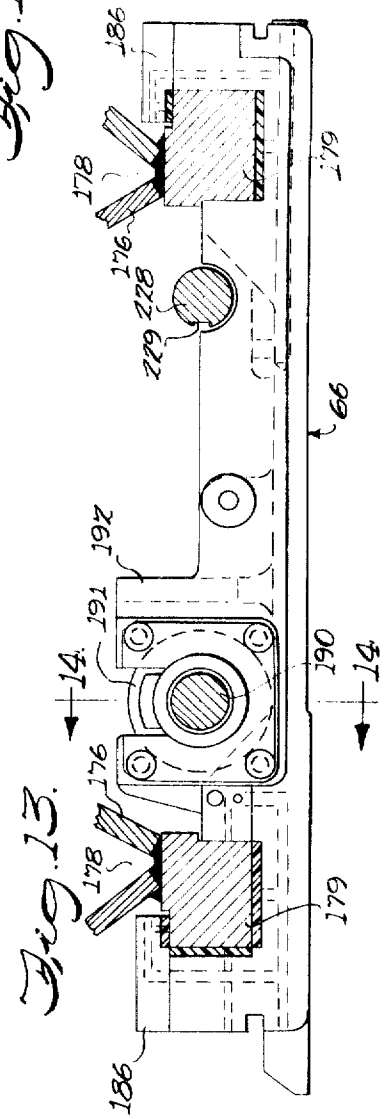


Fig. 13.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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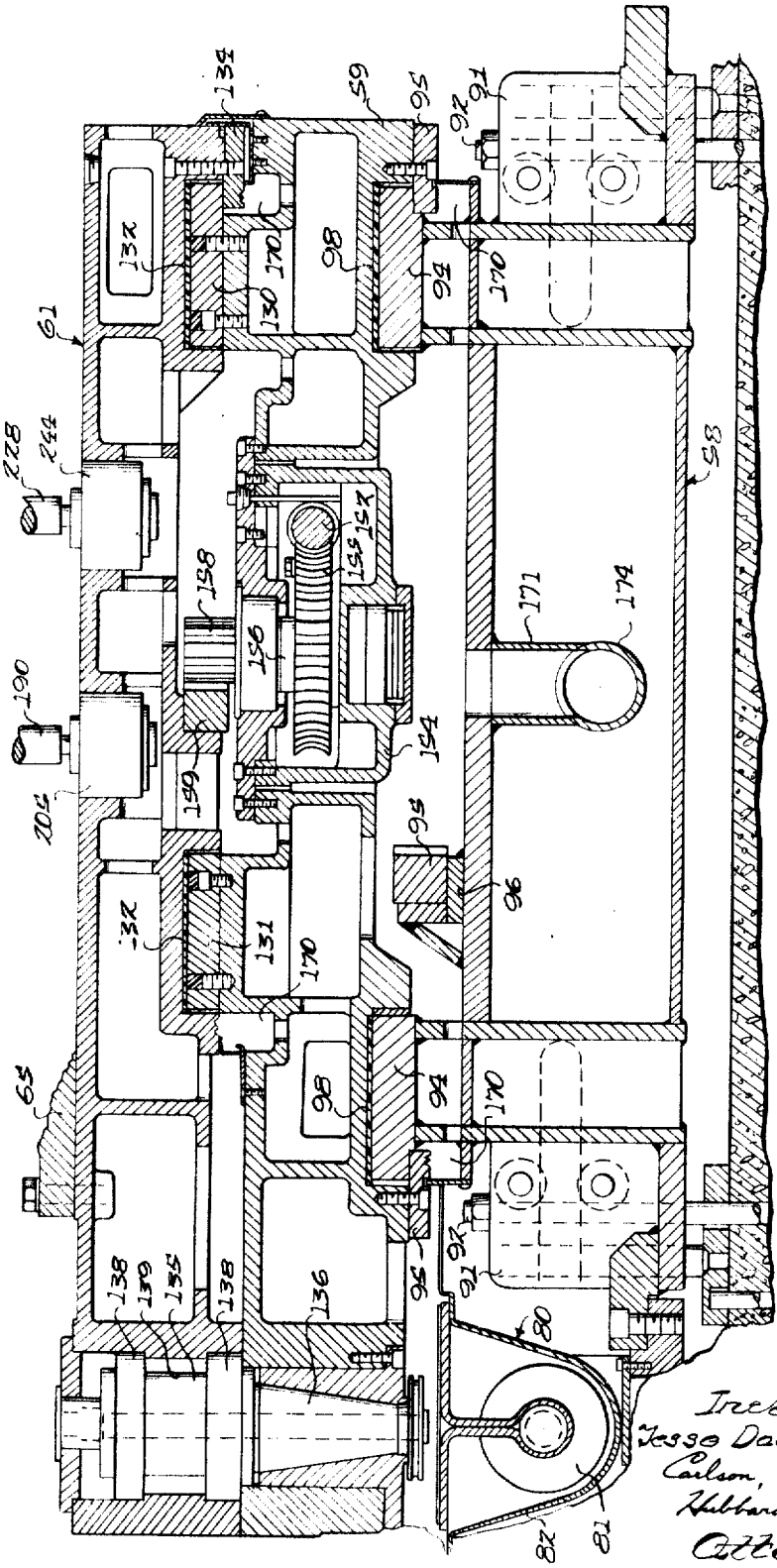


Fig. 8.

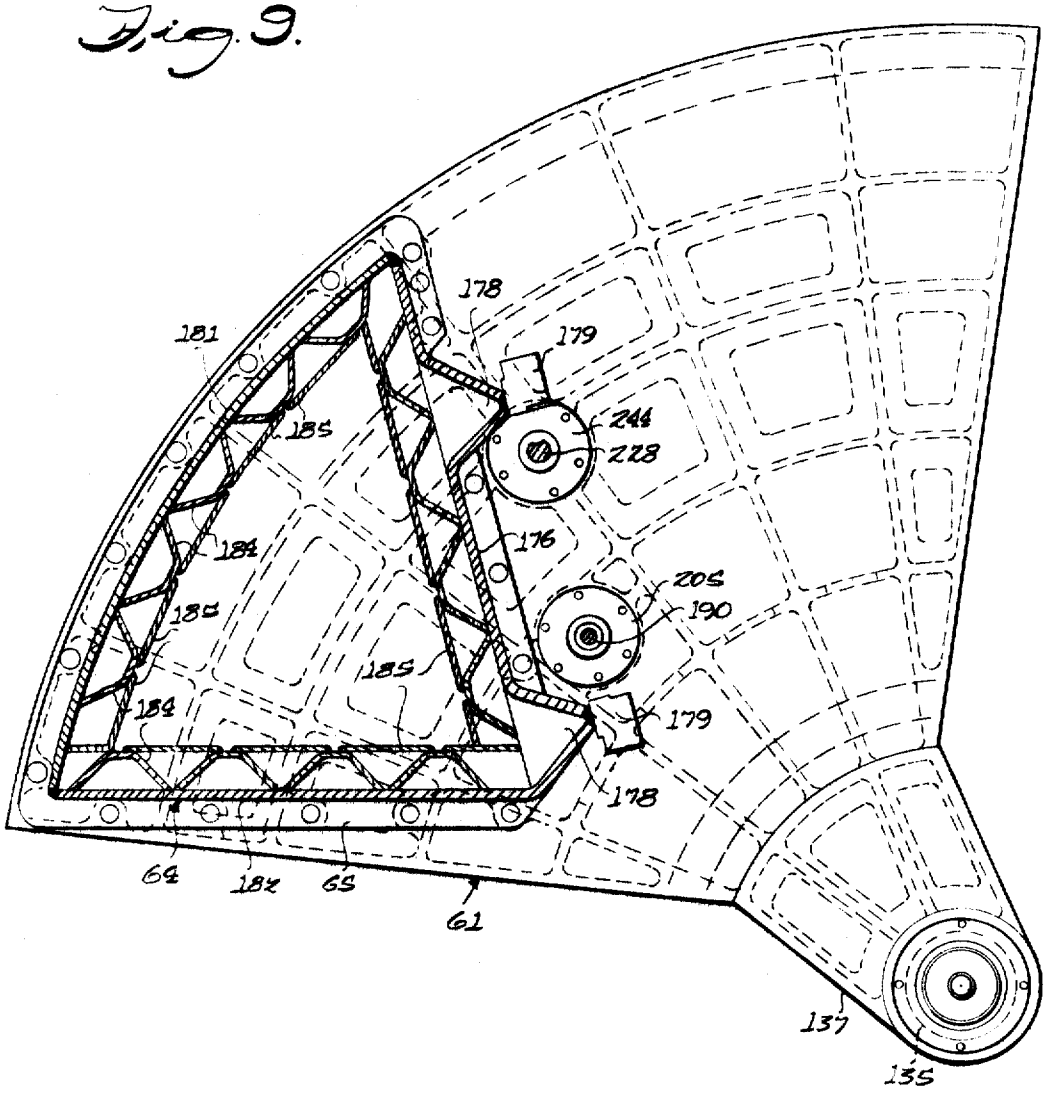
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May 21, 1968 J. DAUGHERTY Re. 26,393

HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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Fig. 9.

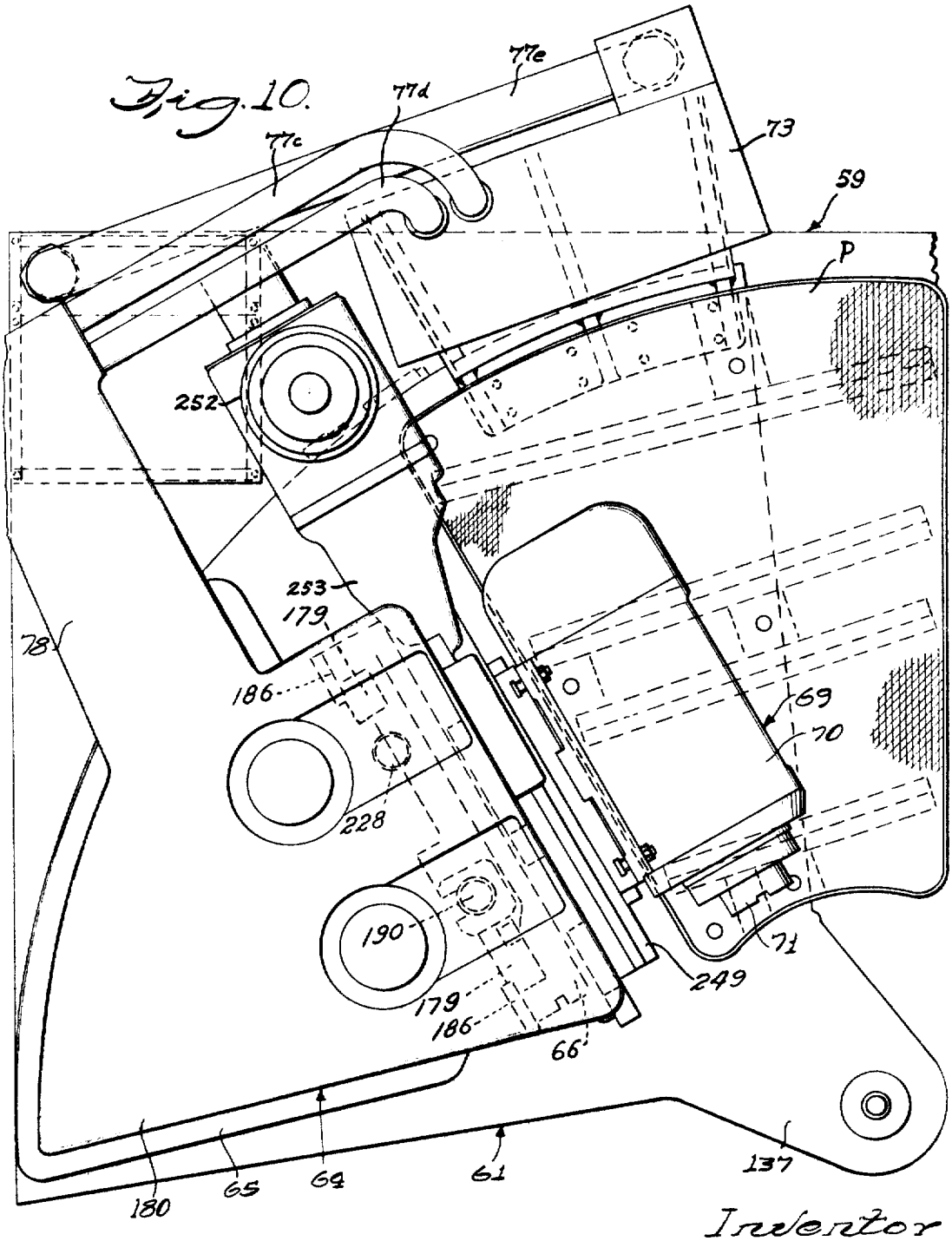


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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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Fig. 10.



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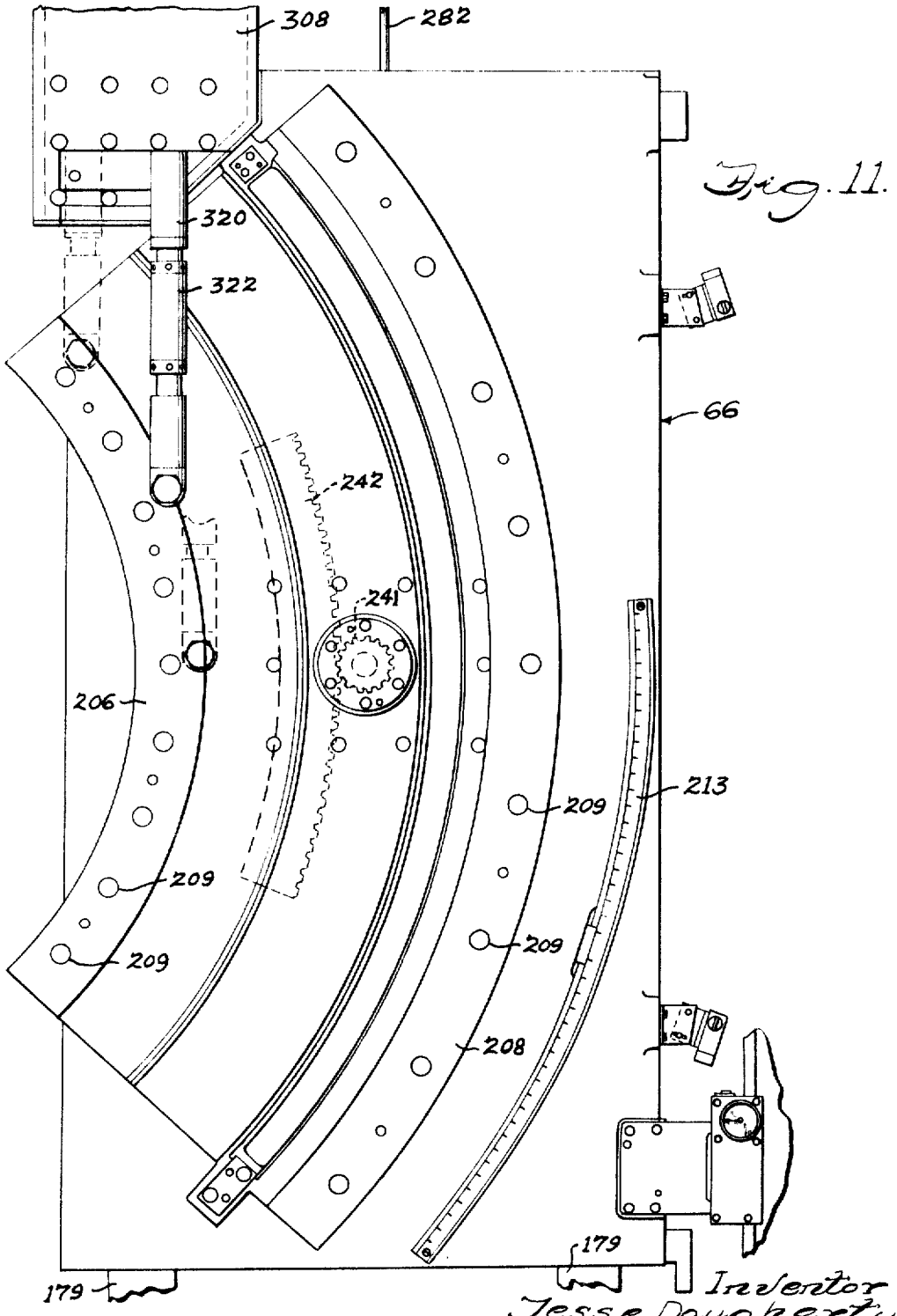


Fig. 11.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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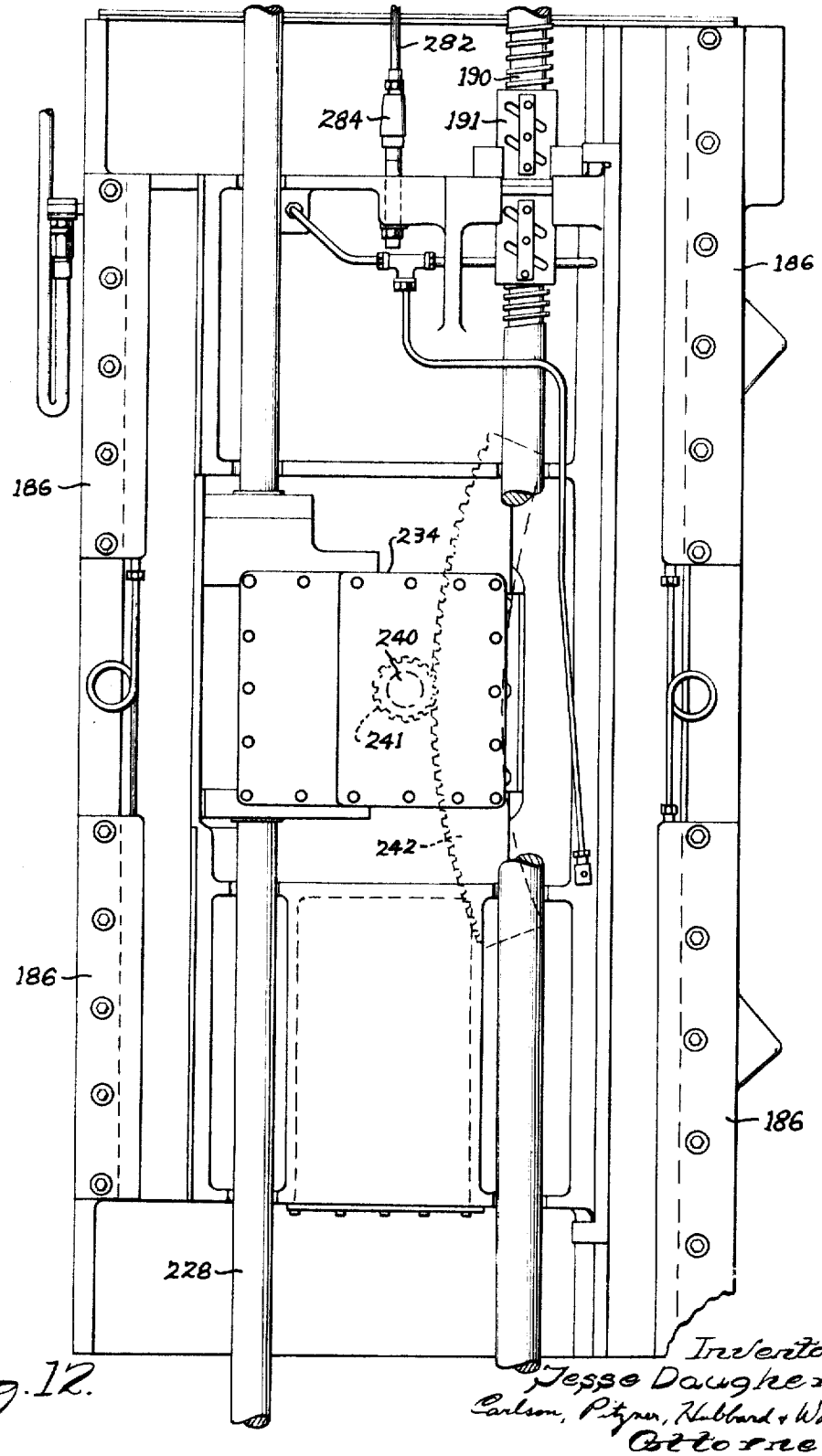


Fig. 12.

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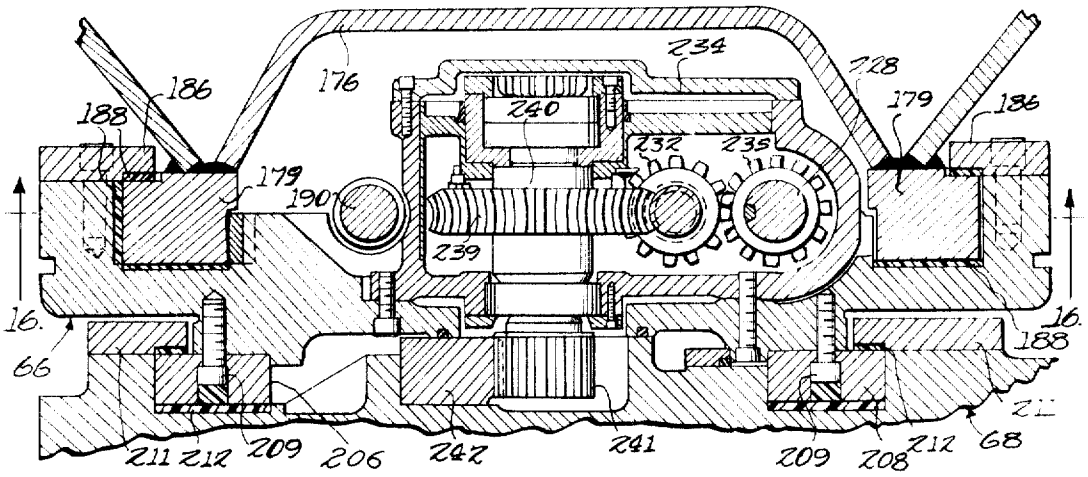


Fig. 15.

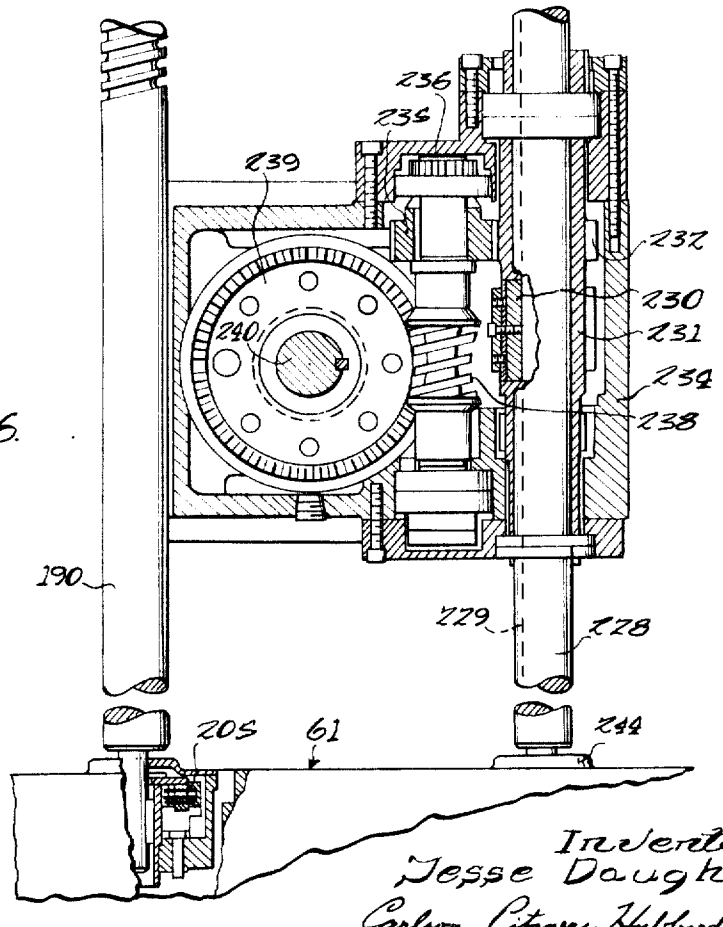


Fig. 16.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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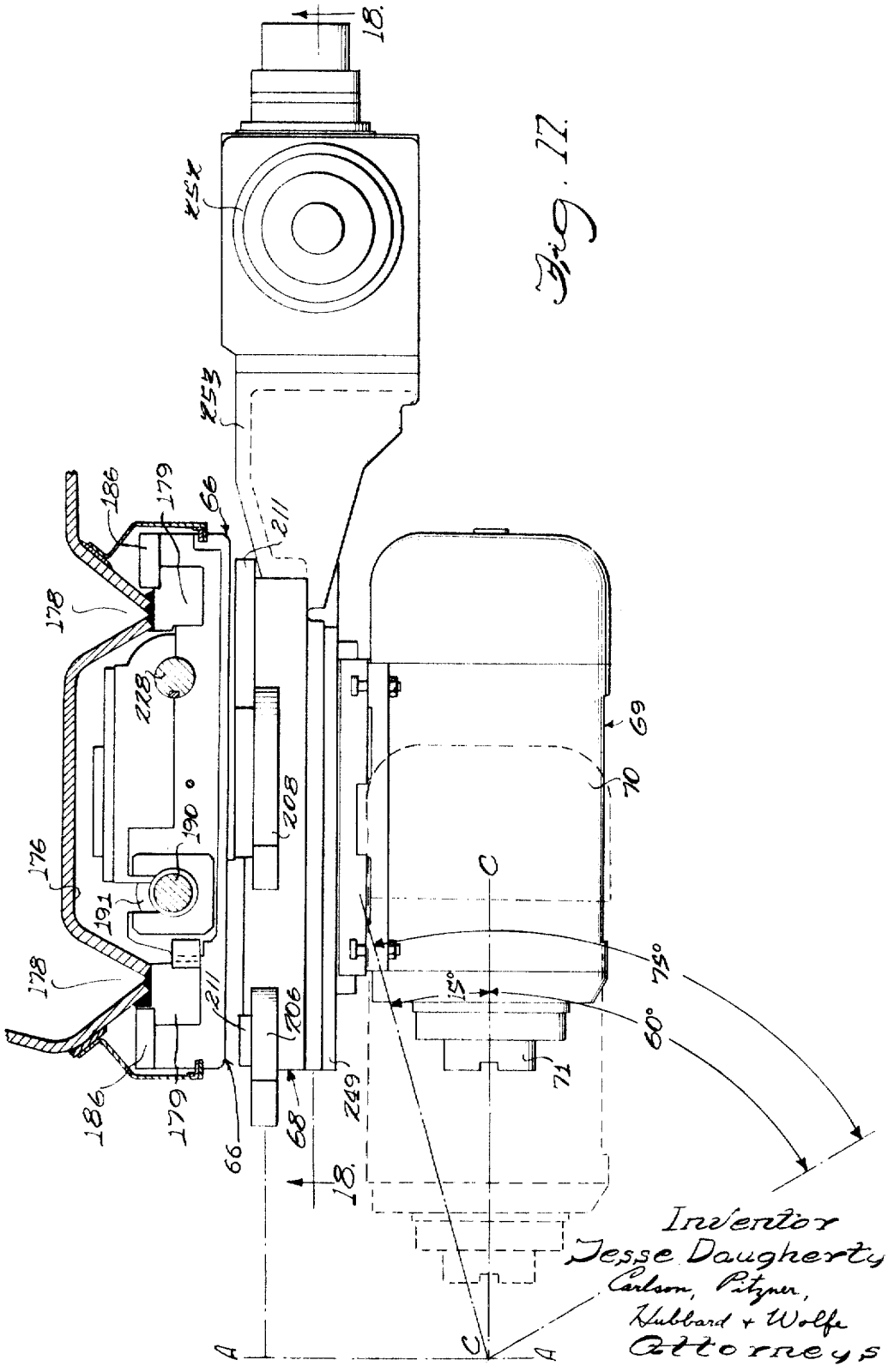


Fig. 17.

Inventor
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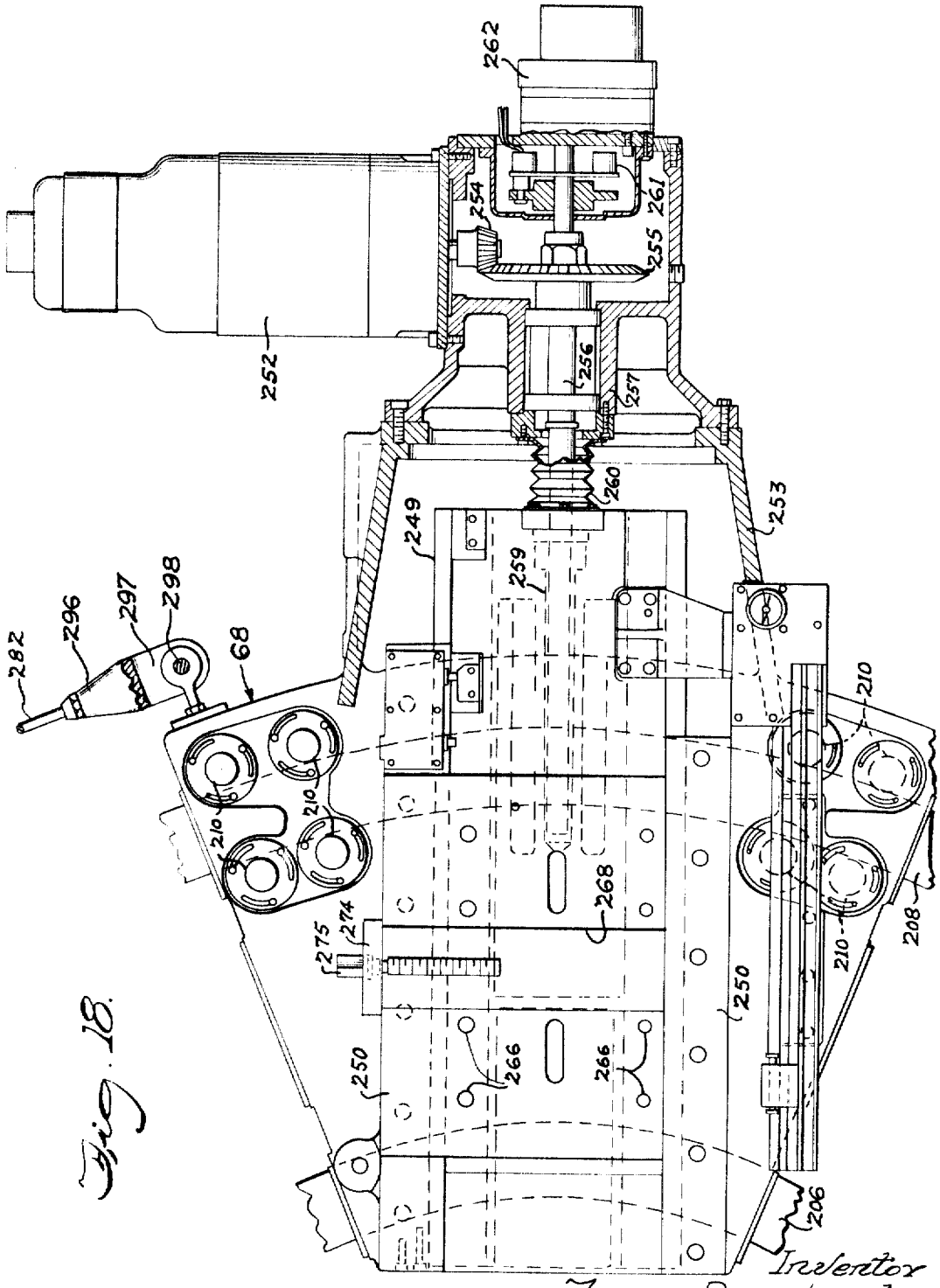


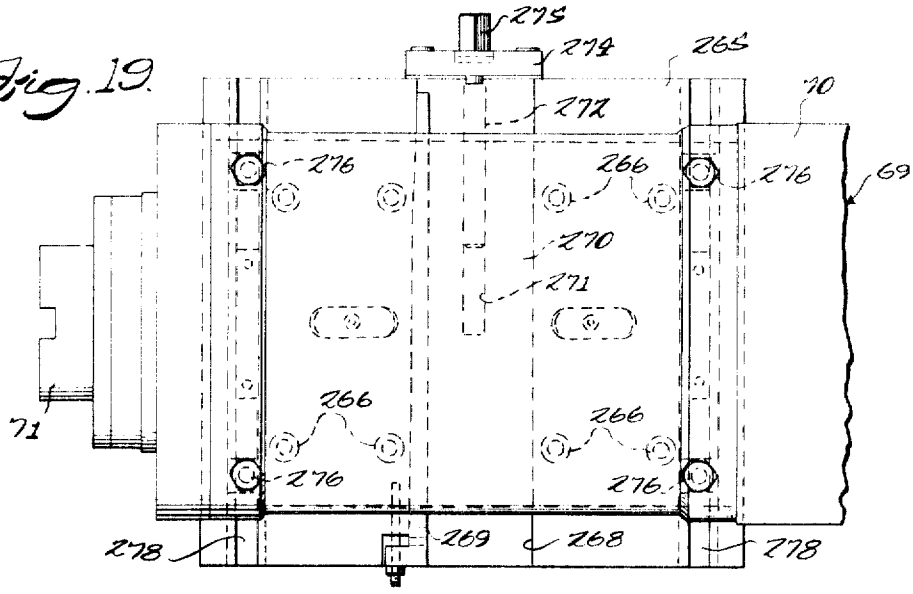
Fig. 18.

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Fig. 19.



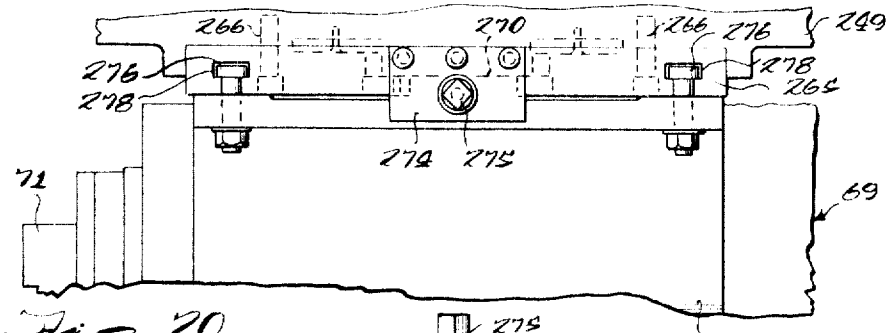


Fig. 20.

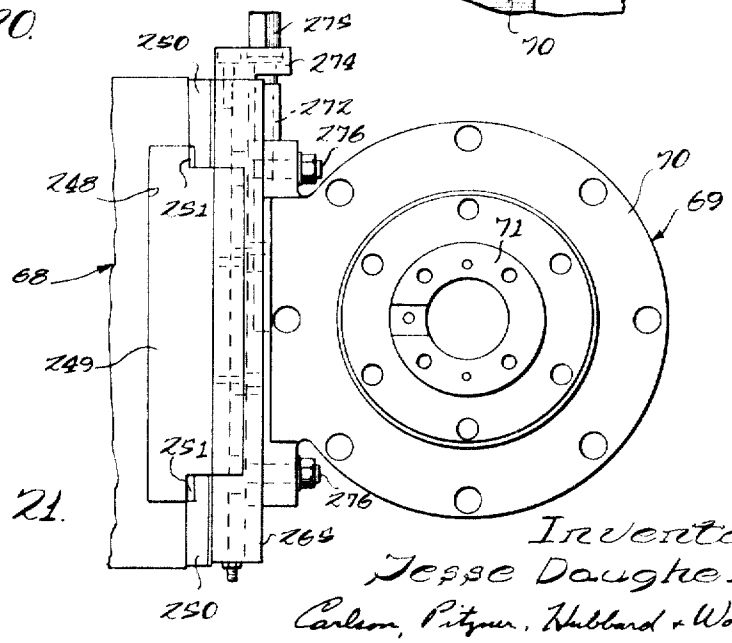


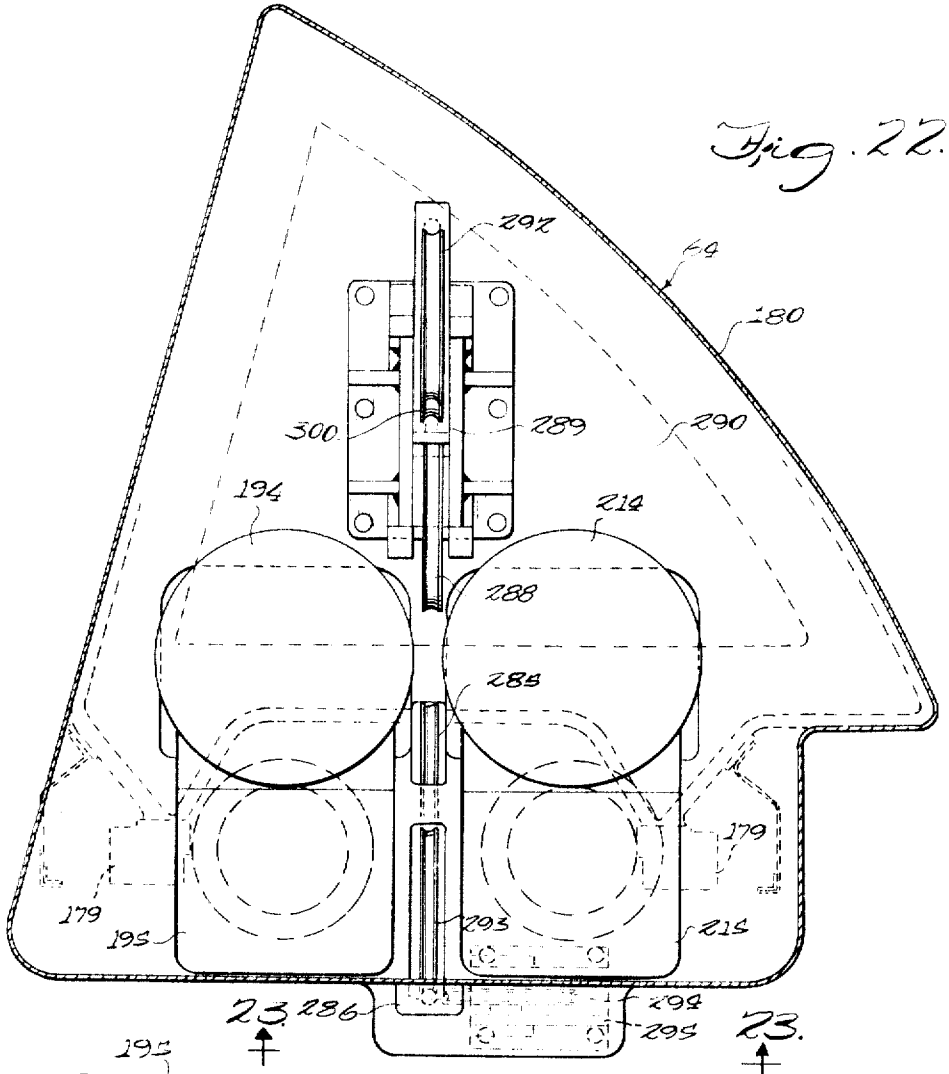
Fig 21.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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Fig. 22.



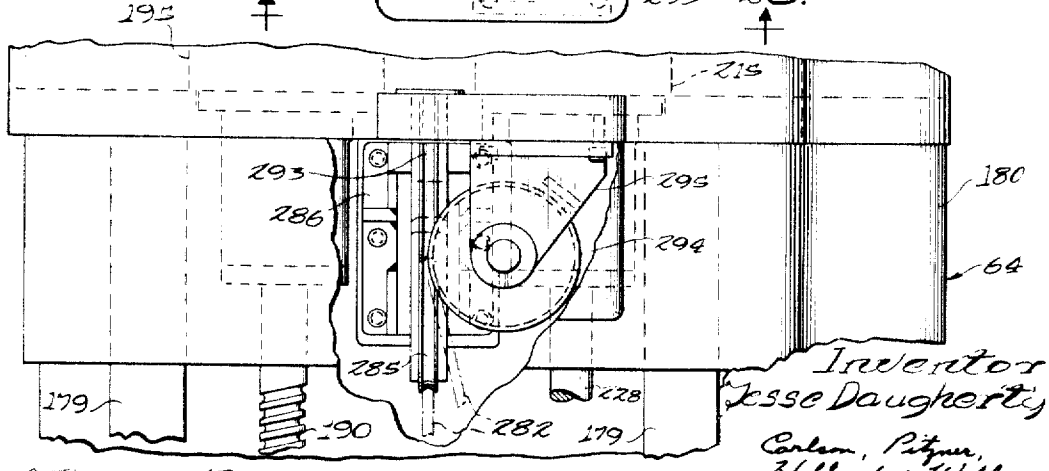


Fig. 23.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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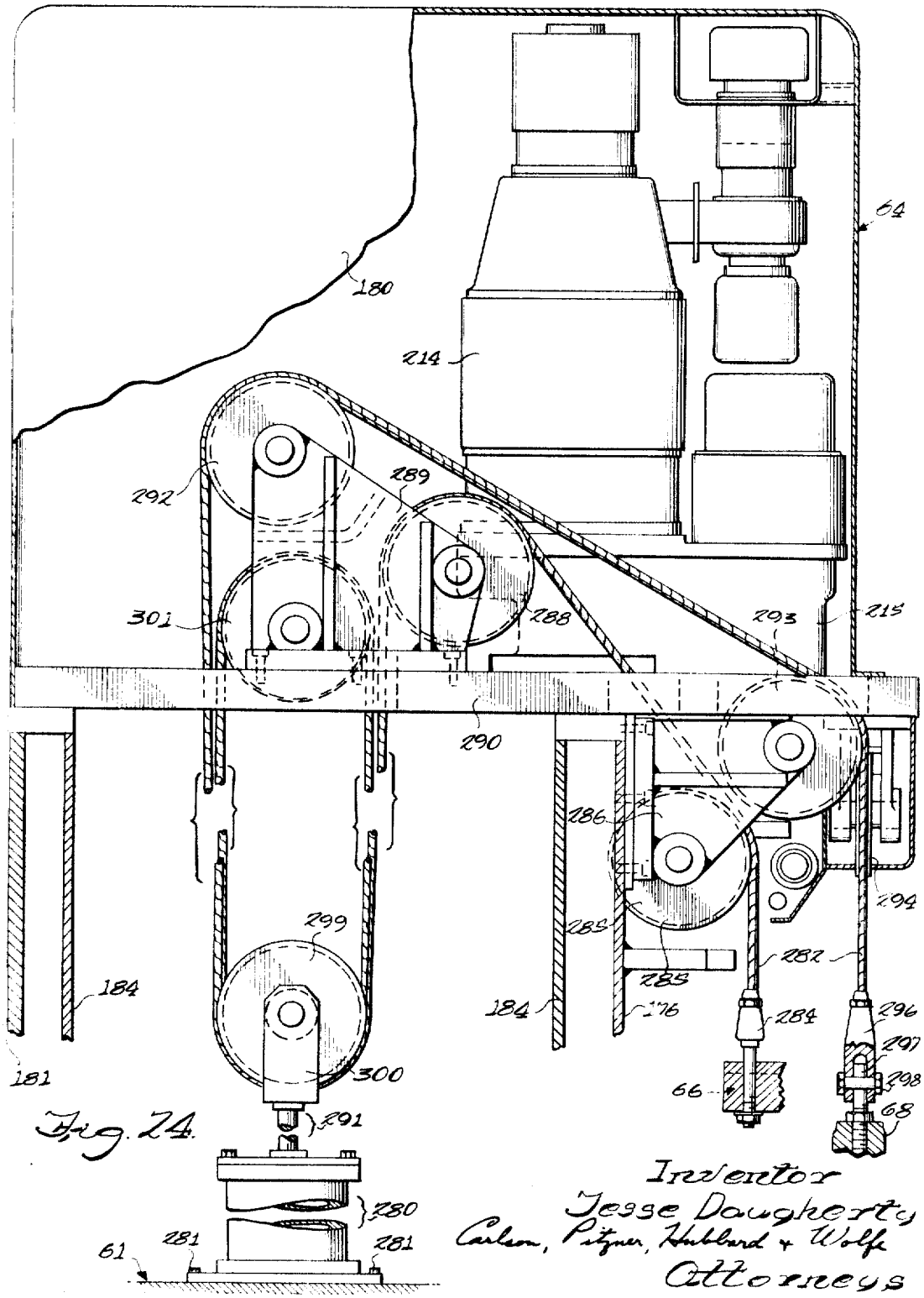


Fig. 24.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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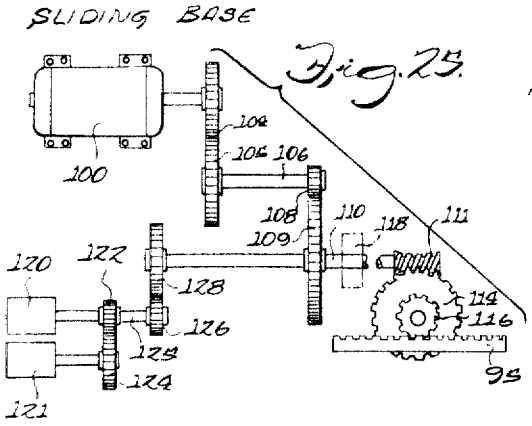


Fig. 25.

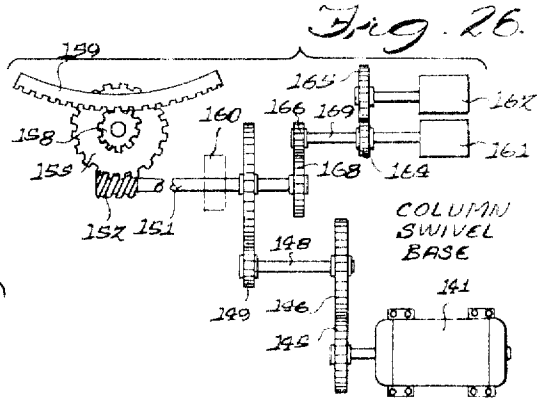


Fig. 26.

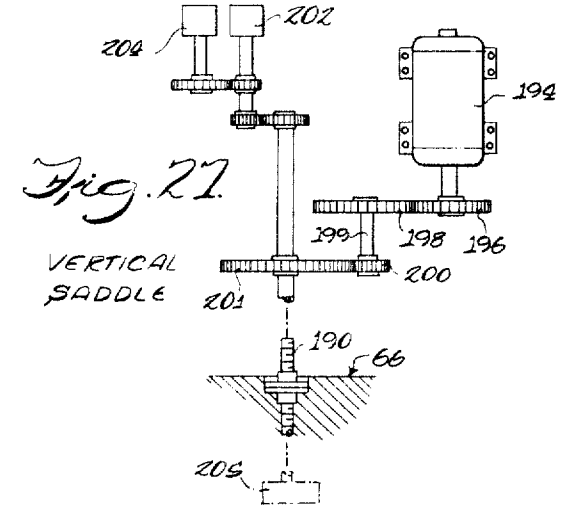


Fig. 27.

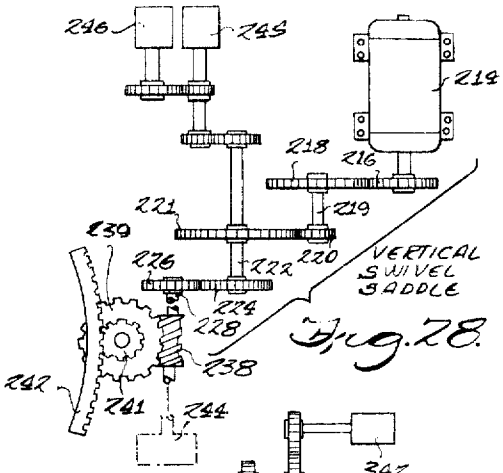


Fig. 28.

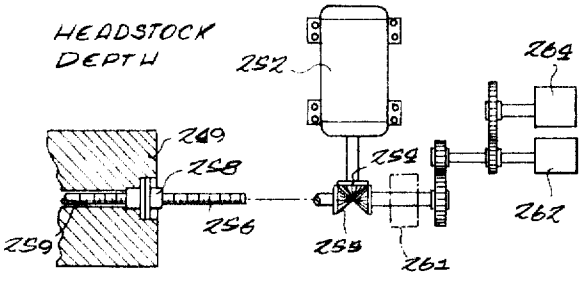


Fig. 29.

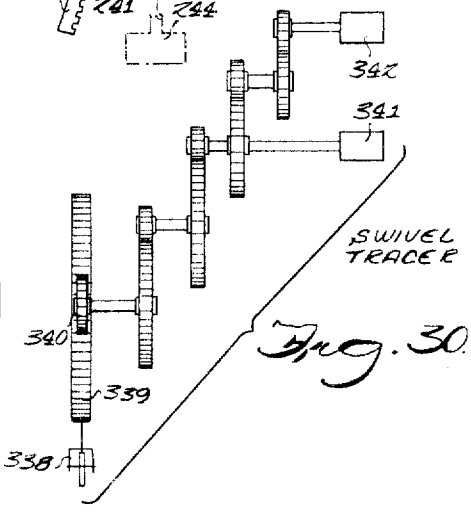


Fig. 30.

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May 21, 1968 J. DAUGHERTY Re. 26,393

HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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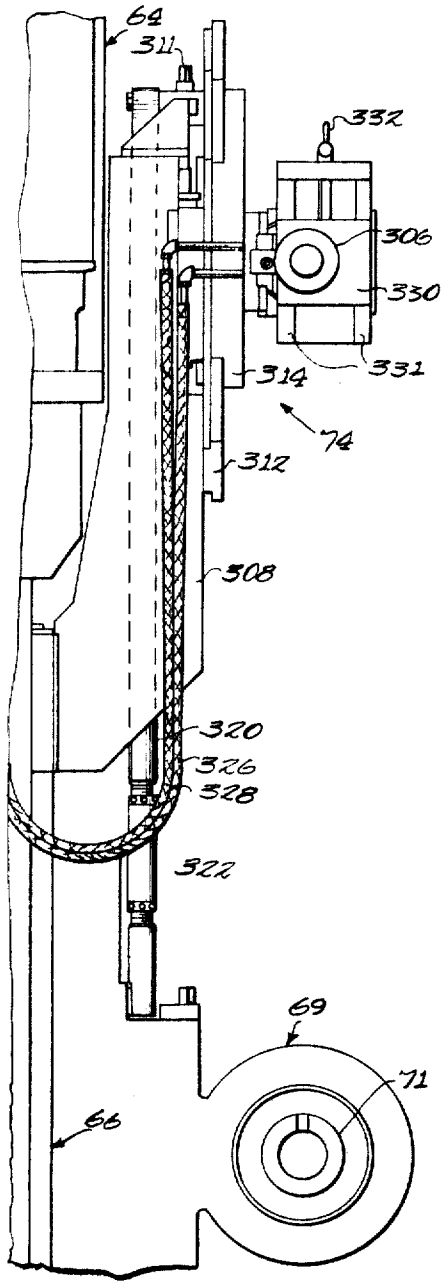


Fig. 32.

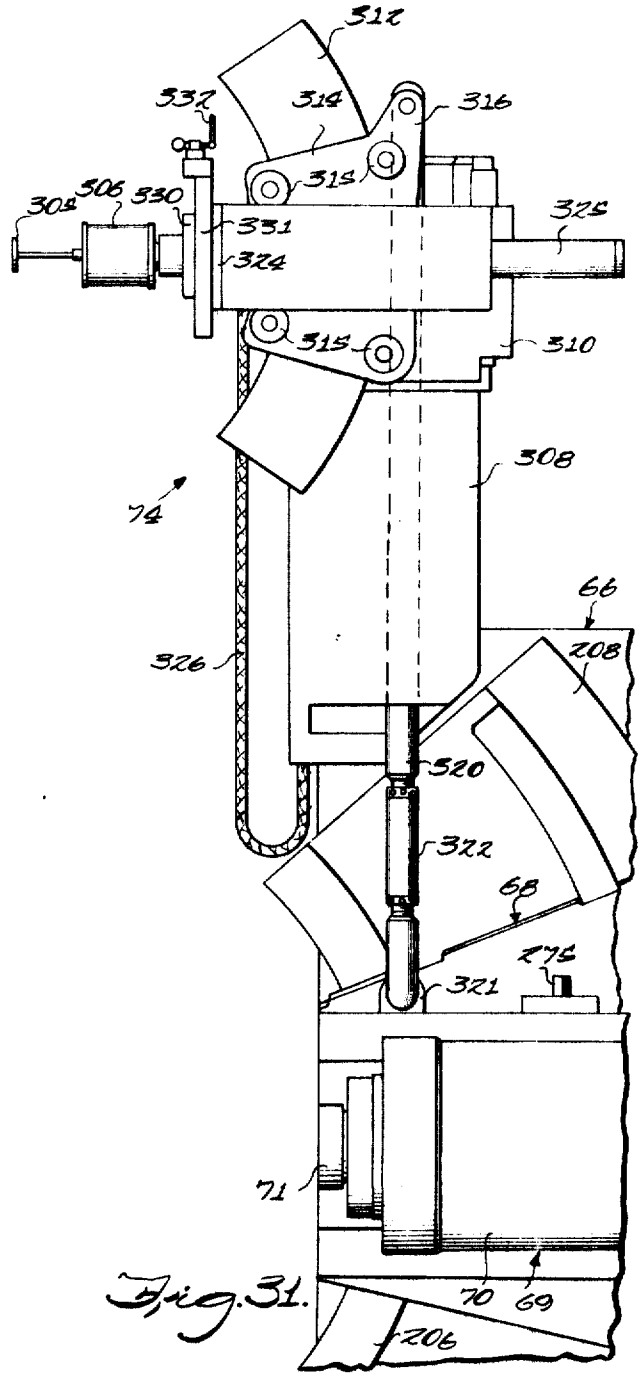


Fig. 31.

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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Fig. 33.

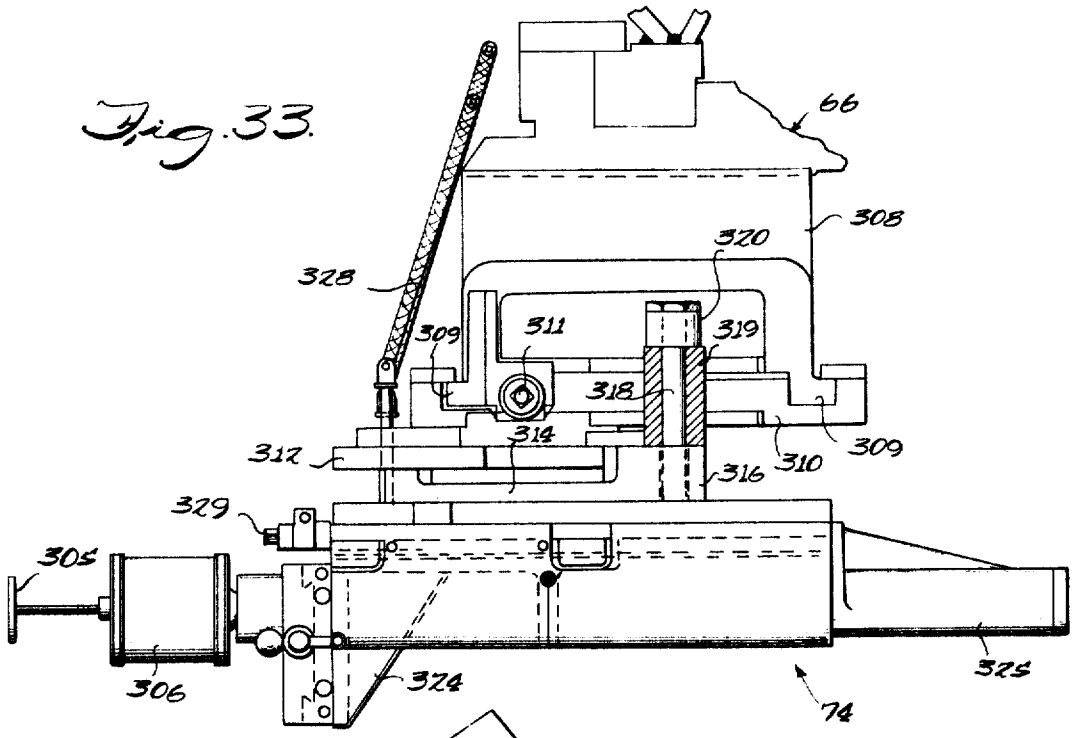
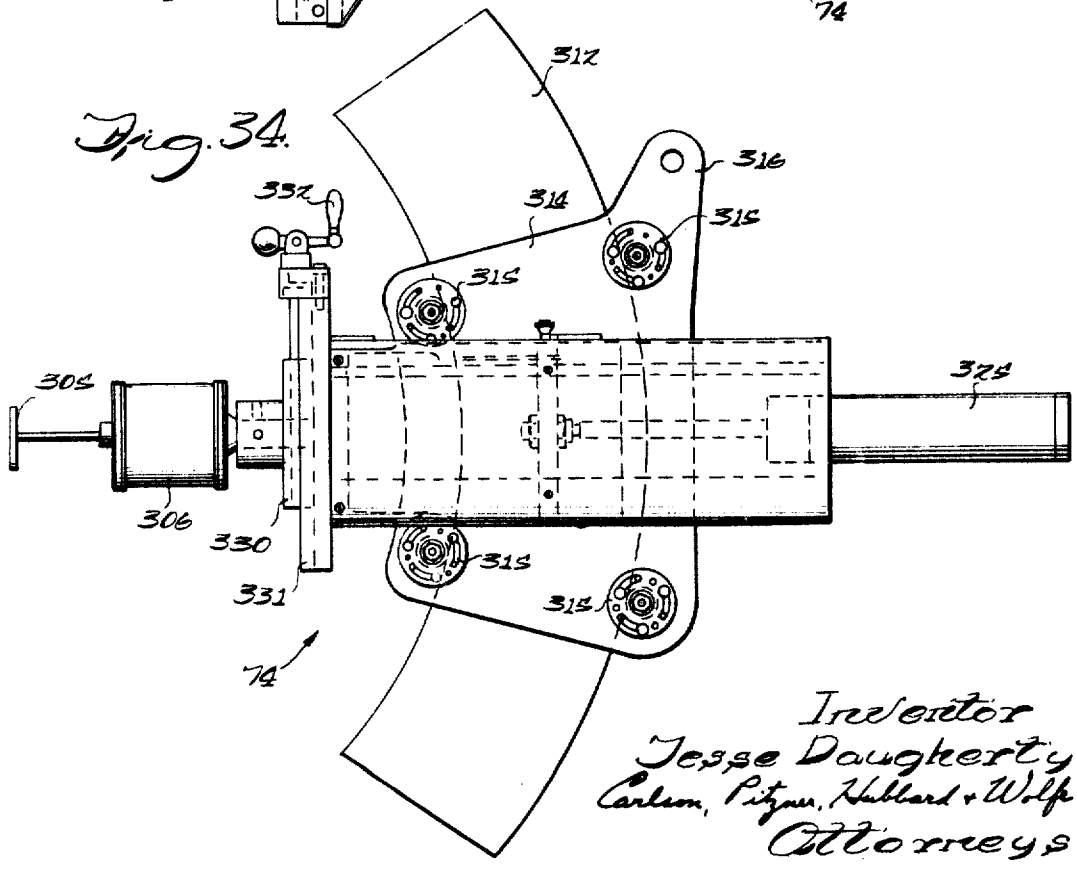


Fig. 34.



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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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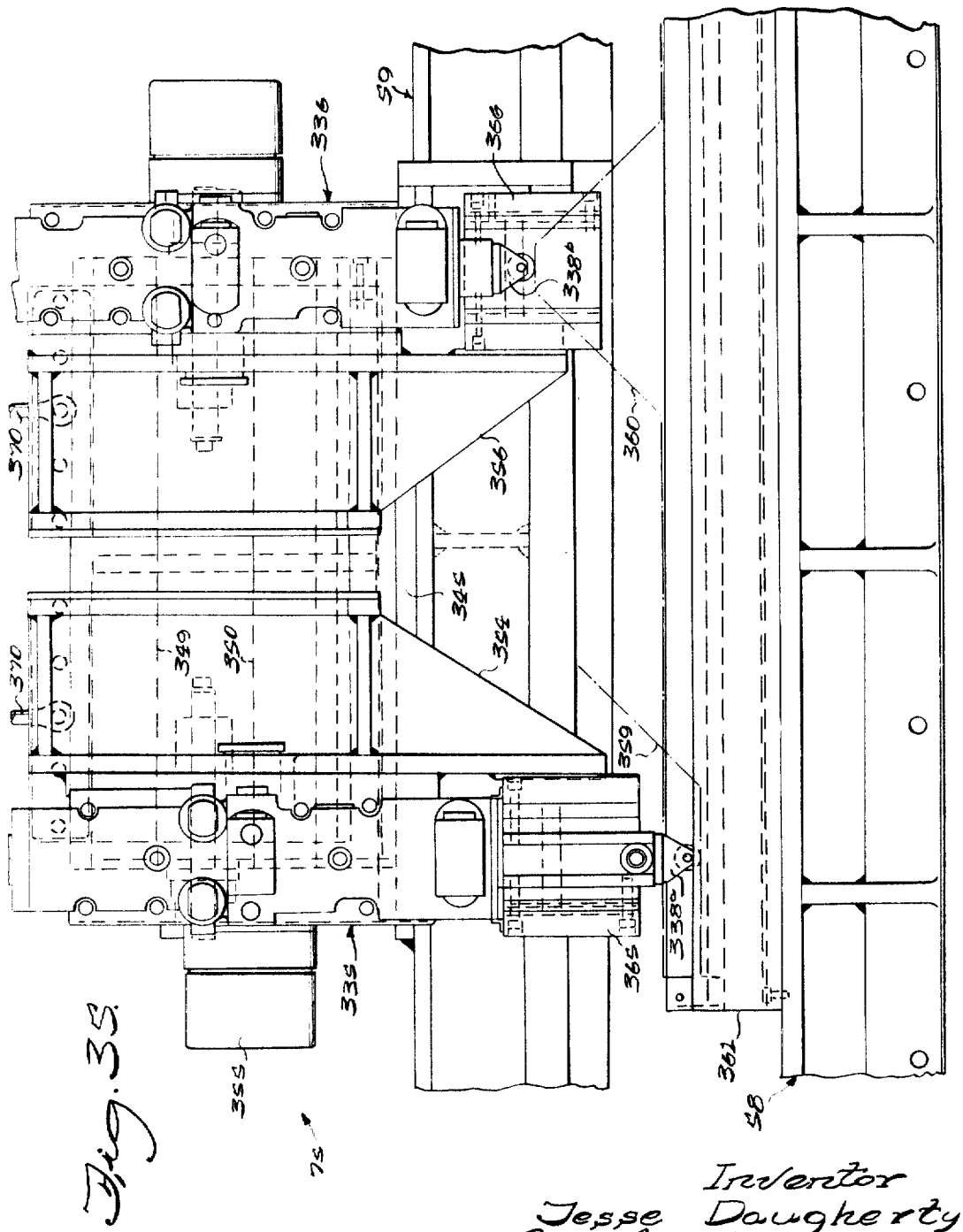


Fig. 35

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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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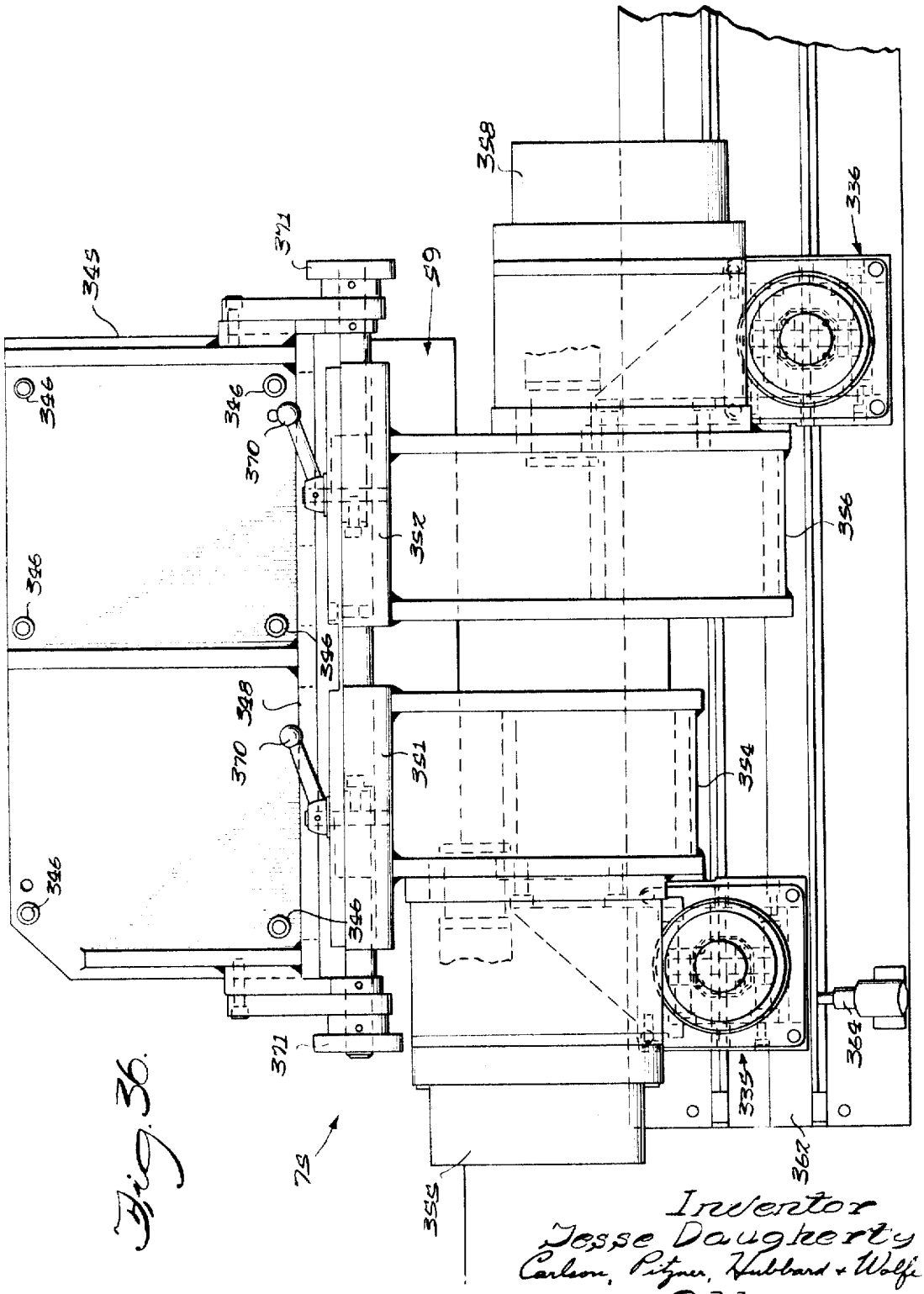


Fig. 36.

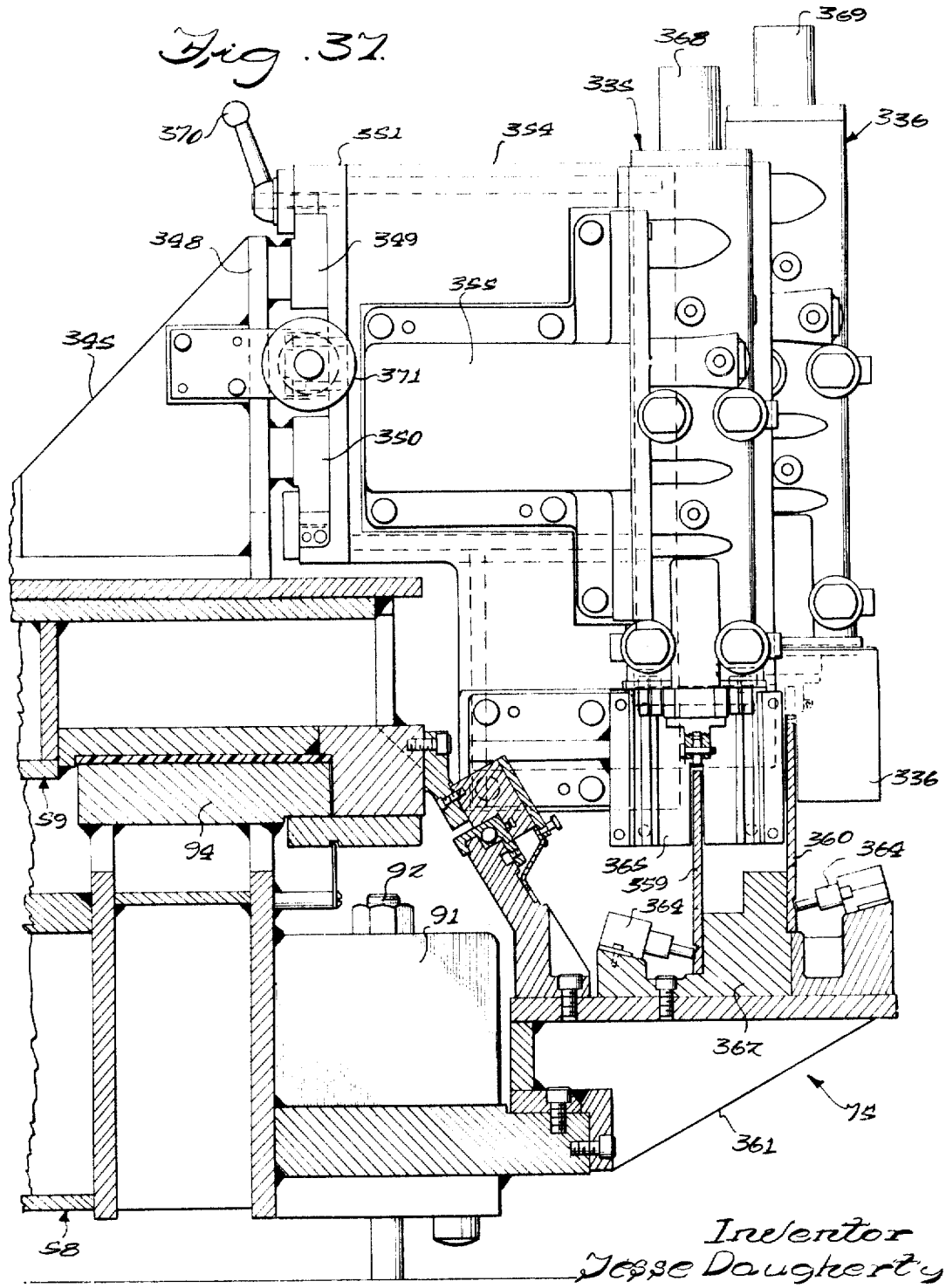
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HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

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Fig. 37.



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United States Patent Office

Re. 26,393
Reissued May 21, 1968

26,393
HIGH-SPEED FLOOR TYPE CONTOUR MILLING MACHINE

Jesse Daugherty, Hollywood, Fla., assignor to Giddings & Lewis Machine Tool Company, Fond du Lac, Wis., a corporation of Wisconsin

Original No. 2,863,361, dated Dec. 9, 1958, Ser. No. 467,771, Nov. 9, 1954. Application for reissue Oct. 16, 1967, Ser. No. 676,661

9 Claims. (Cl. 90—13)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A floor type contour milling machine having a relatively long fixed base, a sliding base mounted on the fixed base, a generally sector shaped swivel base movable in an arcuate path on the sliding base, an upstanding column of generally triangular cross section fixed to the swivel base and movable therewith, a vertically reciprocable saddle carried by the column and having a vertical swivel saddle mounted thereon carrying a headstock adapted to receive a cutter and power drives for moving the saddles and the bases relative to each other. A source of signals is provided which automatically controls the power drives for effecting a total of five motions of the cutter relative to a workpiece in simultaneous combinations.

The present invention relates to the field of machine tools, and, more specifically, to milling machines. The invention finds particular, but not exclusive, utility in a large, high-speed, floor type contour milling machine which is especially well adapted for automatic control.

One object of the invention is to provide a high-speed, high-power, floor type milling machine which is useful in pilot or tracer controlled machining of aircraft parts and various other workpieces.

Another object is to provide a machine of the character set forth and capable of effecting a total of five different pilot or tracer controlled motions of the cutter relative to the work. A related object is to provide a machine in which any four of the five motions are available in a simultaneous combination.

A further object is to provide a machine of the foregoing type which is particularly well suited for the precision machining of forgings and extrusions of light, nonferrous metal on a mass productive basis.

Still another object is to provide a machine of the character set forth and having a novel counterbalancing arrangement for certain major elements which are movable in a vertical plane.

The objects of the invention thus generally stated, together with other objects and advantages, will become more apparent as the following description proceeds, taken together with the accompanying drawings, in which:

FIGURE 1 is a perspective view of a high-speed, floor type milling machine exemplifying the present invention, such view including a workpiece and template support alongside of the machine. FIG. 1A is a diagrammatic view showing the major elements of such machine and their relation to the cutter.

FIG. 2 is a plan view of the illustrative machine illustrated in FIG. 1.

FIG. 3 is an end elevation of the machine shown in FIGS. 1 and 2.

FIG. 4 is an enlarged fragmentary plan view showing a section of the fixed bed of the machine.

FIG. 5 is a plan view of the sliding base of the machine, including certain driving mechanism.

FIG. 6 is an enlarged fragmentary longitudinal sectional view taken through the fixed base and the sliding base of the machine and in the plane of the line **6—6** in FIG. 5.

FIG. 7 is an enlarged transverse sectional view through the fixed base and the sliding base of the machine, taken in the plane of the line **7—7** in FIG. 5.

FIG. 8 is an enlarged transverse sectional view taken through the fixed, sliding and swivel bases of the machine in the plane of the line **8—8** in FIG. 5.

FIG. 9 is a horizontal sectional view taken through the lower portion of the machine column and showing the swivel base in plan.

FIG. 10 is a plan view of the machine column, headstock, swivel base, and associated parts.

FIGS. 11 and 12 are front and rear elevations, respectively, of the vertical saddle which is mounted on the machine column.

FIG. 13 is a horizontal sectional view through one portion of the vertical saddle and its associated column structure.

FIG. 14 is a fragmentary vertical sectional view taken through the vertical saddle drive nut and in the plane of line **14—14** in FIG. 13.

FIG. 15 is a view similar to FIG. 13 but taken through the swiveling drive of the vertical saddle.

FIG. 16 is a fragmentary vertical sectional view through the drive shown in FIG. 15 and in the plane of the line **16—16**.

FIG. 17 is a horizontal sectional view through the upper portion of the column and showing the vertical saddle and headstock in plan.

FIG. 18 is a vertical sectional view taken in the plane of the line **18—18** in FIG. 17 and showing the headstock depth control drive and the vertical swivel saddle mounting.

FIGS. 19, 20 and 21 are enlarged, fragmentary elevation, plan and end views, respectively, showing the headstock offset adjustment.

FIGS. 22 and 23 are, respectively, plan and fragmentary elevational views of the upper portion of the machine column with a part of the column housing removed to bring out inside details.

FIG. 24 is an enlarged fragmentary vertical sectional view through the upper portion of the machine column and illustrating the novel counterbalancing mechanism.

FIGS. 25, 26, 27, 28 and 29 are diagrammatic views illustrating the motor drives for controlling the motions of the sliding base, swivel base, vertical saddle, vertical swivel saddle, and headstock depth slide, respectively.

FIG. 30 is a diagrammatic view illustrating a typical gear train between a tracer of the rack and pinion type and certain associated selsyn motors.

FIG. 31 is a side elevation of the profiling tracer unit mounted on the upper portion of the machine column.

FIG. 32 is an end elevation of the unit shown in FIG. 31.

FIGS. 33 and 34 are enlarged plan and side elevational views, respectively, of the profiling tracer unit and its mounting.

FIGS. 35 and 36 are, respectively, side elevation and plan views of the swivel tracer devices and their associated mountings.

FIG. 37 is an end elevational view of the swivel tracer units shown in FIGS. 35 and 36, but with certain neighboring portions of the fixed and sliding bases shown in transverse section.

While the invention is susceptible of various modifications and alternative constructions, a certain machine constituting an illustrative embodiment has been shown in the drawings and will be described below in considerable detail. It should be understood, however, that there is no intention to limit the invention to the specific form of the machine disclosed herein, but, on the contrary, the intention is to cover all modifications, alternative constructions and equivalents falling within the spirit and scope of the invention as expressed in the appended claims.

GENERAL MACHINE ORGANIZATION

Referring more specifically to FIGS. 1, 2 and 3, the invention is there exemplified in a high-speed floor type contour milling machine **50** which in this instance is set up to machine a workpiece W. The latter happens to be a forging of light non-ferrous metal ultimately destined to be an aircraft structural component. A relatively heavy work fixture **51** supports the workpiece W during machining, and for this purpose has an upstanding wall **52** which includes a series of substantially parallel T-slots **54** in its front face. The fixture **51** rests upon, and is fixed to, a bed **55** mounted in the floor alongside the machine **50** and which may be provided with transverse T-slots **56**. Although closely associated with the machine **50**, the work supporting fixture **51** and its bed **55** are not actually parts of the machine.

Turning now to the machine **50**, the same comprises a relatively long fixed base **58** which may be secured to an underlying foundation in any suitable manner. The fixed base **58** carries on its top side a sliding base **59** which is adapted to be moved longitudinally of the fixed base by reason of a runway defined on the latter. In order to keep out chips and other foreign material, this runway is covered by telescoping guards **60** located on either end of the sliding base and which automatically extend or collapse as an incident to movement of the sliding base. The sliding base **59**, in turn, supports a swivel base **61**. By reason of certain supporting and guiding elements interposed between the sliding base **59** and the swivel base **61**, the latter is adapted to be shifted in an arcuate path along the top of the sliding base. These supporting and guiding elements are also protected against the entry of chips and foreign materials by telescoping guards **62** situated on both sides of the swivel base **61**.

Rigidly fixed to the top of swivel base **61** and projecting upwardly therefrom is a column **64**. The bottom of the column **64** is surrounded by an integral flange **65** which is bolted solidly to the swivel base. The column **64** serves as a support for a vertical saddle **66** which is mounted for vertical sliding movement on one side of the column. The vertical saddle **66** carries a vertical swivel saddle **68** which is movable bodily therewith. Supporting and guiding elements interposed between the vertical saddle **66** and the vertical swivel saddle **68** permit arcuate movement of the latter in a vertical plane. The vertical swivel saddle, in turn, supports a headstock **69** comprising an electric motor **70** and a spindle **71** coupled directly to the motor. The motor **70** in this case is water cooled and may have a rating on the order of 20 to 50 horsepower. The spindle **71** drivingly supports a milling cutter **72** which may be of any form appropriate to the work being machined.

The motions of the major elements of the machine **50** are subject to pilot or tracer control, either singly or in various combinations. This is accomplished by the use of a profiling tracer assembly **74** fixed to the vertical saddle **66** in substantially overlying relation with the headstock. Tracer control of the swiveling motions of the machine is effected by means of swivel tracer assembly **75** carried by the sliding base **59**.

Power is supplied to the machine **50** from a main power and control panel **76** situated alongside of the machine and housed within a metal cubicle. The panel **76**, which also includes a number of electrical controls, is connected to the machine **50** via flexible main conduits **77a**, **77b**. The latter extend from the panel cubicle to a bracket **78** fixed to the top of the column and have sufficient slack to accommodate the full travel of the sliding base and the column. The conduits **77a**, **77b** connect with rigid conduits **77c**, **77d** leading from the bracket **78** to a control box **73**, the latter being rigidly mounted on the swivel base **61** adjacent the operator's platform P. A slack flexible conduit **77e** extends from the box **73** to the sliding base **59**.

An ancillary but highly important attachment operatively associated with the machine **50** is a chip conveyor **80**. As indicated in FIGS. 2, 3 and 4, the latter is mounted adjacent the fixed base **58** and is comparable in length with it. In this case, the chip conveyor comprises a screw or auger element **81** which rotates in an underlying trough **82**. The auger **81**, driven by means of motor **84** and gear unit **85**, is adapted to move chips from the region of the cutter back toward the motor and gear unit **84**, **85**, discharging the chips in a disposal chute **86**.

THE BASE ASSEMBLY

In general, the base assembly comprises three major elements, namely, the fixed base **58**, the sliding base **59**, and the swivel base **61** (FIGS. 4–7, inclusive). The fixed and sliding bases **58**, **59**, in this instance happen to be fabricated by welding together steel plates and other structural elements, while the swivel base **61** may be formed as an internally ribbed casting.

As shown in FIGS. 2, 4, 6, 7 and 8, the fixed base **58** is a relatively long box-like member which, for convenience in manufacture and assembly, may be made in longitudinal sections secured together as by means of bolts **90** (FIG. 4). The base **58** may be secured to an appropriate foundation by means of a plurality of anchor feet **91** rigidly fixed to its sides and each provided with a hold-down bolt **92**. Projecting slightly above the top of the fixed base **58** and disposed thereon in laterally spaced relation are a pair of ways **94**. In this case, the ways **94** are of flat configuration and extend the length of the base **58**, defining a runway for the sliding base **59** and supporting the same.

Rigidly fixed to the top of the base **58** and nested between the ways **94** is a rack **95** which extends longitudinally of the base and parallel to the ways **94**. The rack **95** may be formed in sections and secured in place by means of a mounting bracket **96**. The rack **95** cooperates with drive gearing carried by the sliding base **59** to effect movement of the latter longitudinally of the ways **94**.

The sliding base **59** (FIGS. 1, 2 and 5), is of generally rectangular form and is slidably mounted on the ways **94**, being retained in place as by means of cleats **97** (FIG. 7). Those portions of the sliding base **59** which are opposite the supporting and guiding surfaces of the ways **94** may be equipped with non-metallic wear plates **98**. The latter may be fashioned with suitable oil passages and recesses to define hydrostatic pressure pads and thereby greatly minimize friction along the ways **94**.

The drive for traversing the sliding base **59** along the ways **94** of the fixed base **58** is shown in some detail in FIGS. 5, 7 and 25. The drive comprises an electric motor **100** and gear box **101** rigidly fixed to the right-hand end of the sliding base **59** (as viewed in FIG. 5). The motor **100** may be cooled by means of a small motor driven blower **102** carried by its casing. The gear box **101** houses a transmission (FIG. 25) comprising gears **104**, **105**, countershaft **106**, reduction pinion **108** and output gear **109**. The gear **109** has a direct connection with drive shaft **110** which extends longitudinally of the sliding base **59**. The end of the shaft remote from the gear **109** terminates in a worm **111** journaled within a gear box **112**. The worm **111** meshes with and drives a worm wheel **114** which is fixed to a short

vertically disposed stub shaft **115** journalled in the gear box **112**. The lower end of the stub shaft **115** terminates in a relatively heavy drive pinion **116** which meshes with the teeth of the rack **95**. With the arrangement just described, it will be appreciated that rotation of the motor **100** will effect rotation of the drive pinion **116** and, since the rack **95** is rigidly attached to the fixed base **58**, the result will be motion of the sliding base **59** along the ways **94** of the fixed base.

To guard against accidental movement of the sliding base **59** when the motor **100** is not energized, the sliding base **59** has mounted thereon an electromagnetic brake unit **118** (FIGS. 5 and 25). The unit **118** has elements adapted to engage the drive shaft **110** and, in effect, serves as a clamp which prevents rotation of the shaft **110** as well as the related elements of the drive.

In order to adapt the sliding base drive for automatic operation, including tracer control or magnetic tape control, one or more selsyn units may be coupled to the drive (FIGS. 5 and 25). In this instance, a low-speed selsyn **120** and a high-speed selsyn **121** are mechanically connected by gears **122, 124** and connected to the drive shaft **110** via an intermediate shaft **125** and gears **126, 128**, the latter being coupled directly to the shaft **110**.

As indicated earlier herein, the swivel base, or column swivel base, **61** is somewhat sector-shaped and is mounted on top of the sliding base **59**, being disposed for arcuate movement about a vertical axis (FIGS. 1, 1A, 2 and 17). This axis, designated "B—B," is situated adjacent one side of the machine and passes through the center of the cutter **72** mounted in the headstock. As shown in FIGS. 2 and 17, the total arcuate swing of the swivel base **61** (which is also the total arcuate swing of the machine elements mounted thereon) in this case happens to be 75°. The parts are so constructed that the swivel base can swing clockwise from a neutral position shown in FIG. 4 for a distance of 60°, and counterclockwise from such neutral position for a distance of 15°.

To support and guide the swivel base **61** during its arcuate movement, the sliding base **59** has fixed on its top side a pair of arcuate or segmental ways **130, 131** (FIGS. 5, 7 and 8). These arcuate ways, in the present instance have flat top surfaces and are disposed in concentric relation with the vertical axis B—B. On its underside, the swivel base **61** is formed with arcuate recesses for registering with the arcuate ways **130, 131** and such recesses are lined with non-metallic wear plates **132** similar to the wear plates **98** described earlier herein. Like the plates **98**, the wear plates **132** may also be formed with recesses defining hydrostatic pressure pads or pockets for minimizing friction. The swivel base is held against the way **130** by means of cleats **134** similar to the cleats **95**. Cooperating with the arcuate ways **130, 131** in guiding the swivel base **61** on the sliding base is an upstanding pivot shaft **135** (FIG. 8). The latter is tightly secured within a tapered seat in the sliding base **59** by means of a tapered shank **136**. An extension **137** of the swivel base fits over the pivot shaft **135** and antifriction bearings **138**, housed within a bearing cavity **139** in such extension, permit the swivel base **61** to be swung about the axis B—B with little friction and substantial accuracy. The pivot shaft may be fashioned with one or more longitudinal bores **140** (not detailed) for supplying lubrication and other services to the swivel base and the elements mounted thereon.

The drive for traversing the swivel base **61** along the arcuate ways **130, 131** of the sliding base **59** is shown most clearly in FIGS. 5, 6, 8 and 26. Such drive comprises an electric motor **141** and gear box **142** rigidly fixed to the left-hand end of the sliding base **59** (as viewed in FIG. 5). Like the motor **100** at the opposite end of the sliding base, the motor **141** is cooled by the small blower **144**. The gear box **142** contains a transmission including gears **145, 146**, countershaft **148**, reduction pinion **149** and output gear **150** (FIG. 26). The latter is directly coupled with a drive shaft **151** which extends longitudinally of the sliding base **59**. The end of the shaft **151** remote from the gear box **142** connects with a worm **152** housed within a gear box **154** (FIGS. 5 and 8). The worm **152** meshes with and drives a worm wheel **155**, the latter being fixed on a vertically disposed stub shaft **156** journaled in the gear box **154**. The upper end of the stub shaft **156** terminates in a relatively heavy drive pinion **158** which meshes with the teeth of an arcuate gear segment **159** rigidly fixed to the underside of the swivel base **61**. By reason of the foregoing driving connections, it will be appreciated that rotation of the motor **141** will effect rotation of the pinion **158**, transmitting a driving torque to the gear segment **159** and thus swinging the swivel base **61** about the pivot shaft **135** and the axis B—B and along the ways **130, 131**.

As in the case of the drive for the sliding base, the drive for the swivel base is provided with an electromagnetic brake unit which serves as a clamp when the motor is idle. By the same token, the swivel base drive is provided with low-speed and high-speed selsyn units **161, 162** coupled thereto by means of gears **164, 165, 166, 168**, and coupling shaft **169** (FIG. 26).

Oil for lubrication of the ways **130, 131** which carry the swivel base **61**, and for lubrication of the ways **94** which carry the sliding base **59**, is drawn from the pressure side of the main hydraulic system (not shown in detail) of the machine **50**. The oil is delivered from a central pump unit (not shown) and supplied under pressure to hydrostatic lubrication pads or pockets formed in the bearing elements which ride on the ways. Oil which is discharged from the hydrostatic pockets along the ways **130, 131** and **94** will be collected in outboard troughs **170** and thence drained down via suitable apertures into the space between the ways **94** (FIGS. 4, 7 and 8). A plurality of drain conduits **171, 172** deliver the collected oil from this region into a main drain line **174** the latter leading to sump **175** of the machine hydraulic system.

THE COLUMN

The column **64** (FIGS. 1, 2, 3, 9 and 10), which serves as a support for the headstock **69**, vertical saddle **66**, and vertical swivel saddle **68**, rises vertically from the top surface of the swivel base **61**, being secured thereto by means of a bottom flange **65** as described earlier herein. The column is disposed with its front face **176** situated approximately centrally of the swivel base **61**. The front face **176** is straddled by a pair of laterally spaced protrusions **178** defining therebetween a central vertical recess. Welded or otherwise rigidly fixed to the protrusions **178** are a pair of vertical ways **179** which guide the vertical saddle **66** as it moves up and down the column. The column is surmounted by a cover **180** which houses various associated mechanisms, and its ways are protected by a flexible curtain **177** (FIG. 1).

In order to achieve maximum arcuate travel of the headstock **69** and the swivel base **61**, as well as a high degree of longitudinal stiffness, the column **64** is given a substantially triangular cross section (FIGS. 9 and 10). Accordingly, column side faces **181, 182** define an acute angle with each other and acute angles with the front face **176**. In the present instances, the face **181** is slightly convex so as to conform to the outer periphery of the swivel base **61** (FIG. 9), making the cross section of the column sector-shaped. Structurally, however, such a cross section may still be considered substantially triangular.

The column **64** may be constructed in various ways and in this case happens to be fabricated by welding component elements together. As shown clearly in FIG. 9, the outer faces **176, 181, 182** are defined by heavy metal plates bent or stamped to the desired shape. These plates are welded together and stiffened internally by means of a series of vertically disposed, outwardly facing channels **184**. The channels **184**, in turn, are reinforced

by a series of vertically disposed plates **185** welded to their backs. The foregoing arrangement produces high strength and rigidity with a minimum of weight.

THE VERTICAL SADDLE

Turning next to the vertical saddle **66** (FIGS. 10 to 17), it will be noted that the same is a generally rectangular, box-like structure nested against the front of the column **64**. The vertical saddle is recessed to receive the column ways **179** and held against the latter by cleats **186**, being slidable therealong. The recesses of the vertical saddle may have non-metallic wear plates **188** which bear against coacting guide surfaces on the ways **179**. The plates **188** may have hydrostatic lubrication pads or pockets (not shown) which are supplied with pressurized oil in the same manner as their counterparts in the base assembly.

Up and down sliding movement of the vertical saddle along the ways **179** is effected by means of a vertically disposed elevating screw **190** (FIGS. 12 to 16) extending from the swivel base **61** to the top portion of the column. The thread on the screw **190** is formed as a helical ball track to minimize wear and friction. The screw **190** transmits movement to the vertical saddle by means of a ball nut **191** rigidly fixed in a bracket **192** near the top of the vertical saddle (FIGS. 12, 13 and 14), the screw passing through the nut **191** and engaging the same.

Mechanical power to rotate the screw **190** and thereby impart vertical motion to the vertical saddle **66** is provided by an electric motor **194**, similar to the motors **100, 141**, but located in the top portion of the column (FIGS. 3, 22, 23 and 27). Housed within a gear box **195** attached to the motor **194** are gears **196, 198**, countershaft **199**, and gears **200, 201**, the latter gear being coupled directly to the top end of the elevating screw **190** (FIG. 27). Low and high speed selsyn units **202, 204**, for control purposes, are mechanically connected to the vertical saddle drive in the same manner as the selsyn units associated with the base drives. In addition, a clamp in the form of an electric brake **205** (FIGS. 8, 9 and 16) is mounted in the swivel base **61** and coupled to the lower end of the elevating screw **190** to hold the same against movement when the motor **194** is idle.

THE VERTICAL SWIVEL SADDLE

The vertical swivel saddle **68** (FIGS. 3, 17, 18 and 31) which carries the headstock **65**, is attached to the front of the vertical saddle **66**, as indicated earlier herein. The attachment is such that the swivel saddle **68** is movable bodily with the vertical saddle **66** as the same travels up and down the column **64**, and is also movable in an arcuate path relative to the vertical saddle **66**. This is accomplished by means of a pair of arcuate ways **206, 208** rigidly secured, as by cap screws **209**, to the face of the vertical saddle (FIGS. 3, 11 and 18). With the machine in the condition indicated in FIGS. 1 to 3, the ways **206, 208** have their center of curvature situated in line with the center of the cutter **72** or, in other words, on the horiozntal axis A—A. In the present instance, the swivel saddle is guided along the ways **206, 208** primarily by means of two sets of guide bearings **210**, four in each set, which are mounted in the swivel saddle and disposed to roll on opposite edges of the larger way **208** (FIG. 18). The swivel saddle is also provided with cleats **211** which bear against the rear faces of the ways **206, 208**, and non-metallic wear plates **212** which bear against both the front and rear faces of the ways (FIG. 15). The swivel saddle **68** and the ways **206, 208** are arranged and proportioned that the former will be susceptible of swiveling vertically through an arc of 20° above the horizontal axis C—C and 20° below such axis, a total arcuate travel of 40° (FIG. 3). The extent of such travel may conveniently be read on our angular scale **213** on the vertical saddle.

Vertical swiveling movement is imparted to the swivel saddle **68** by means of an electric motor **214** located in the top portion of the column (FIGS. 3, 22, 23 and 24) and an associated drive (FIGS. 15, 16, 23 and 28). The motor **214** is similar to the drive motors **100, 141** and **194** described earlier herein. Housed within a gear box **215** adjacent the motor **214** is a transmission comprising gears **216, 218**, countershaft **219**, gears **220, 221**, countershaft **222** and gears **224, 226** (FIG. 28). The latter is directly coupled to the upper end of a vertically disposed swivel drive shaft **228** extending from the top to the bottom of the column. As shown in FIG. 16, the swivel drive shaft **228** has a keyway **229** extending along the major portion of its length. Slidably keyed to the shaft **228**, as by means of key **230**, is a sleeve **231** having a pinion **232** integral therewith. The sleeve and pinion **231, 232** are housed within a gear box **234** which is rigidly secured to the rear of the vertical saddle **66** and movable bodily therewith. The pinion **232** meshes with another pinion **235** on a worm shaft **236** journaled with the gear box **234**. The worm shaft **236** is integral with a worm **238** which meshes with a worm wheel **239**. The latter is secured to a relatively heavy cross shaft **240** journaled in the gear box but terminating externally in a heavy drive pinion **241**. This meshes with a gear segment **242** (FIGS. 11, 12, 15 and 28) fixed to the rear face of the vertical swivel saddle **68**.

The foregoing drive also includes a clamp in the form of electric brake **244** at the lower end of the swivel drive shaft, and connections to low and high speed selsyn units **245, 246**.

THE HEADSTOCK AND ITS ADJUSTMENTS

As indicated earlier herein, the headstock **69** is carried on the vertical swivel saddle **68** and comprises the motor **70** and the spindle **71** which carries a cutter **72** of any appropriate shape (FIGS. 1, 1A, 3, 10, 17 and 18). The motor may be water cooled and have a capacity on the order of 20 to 50 horsepower.

The headstock is mounted on the vertical swivel saddle for sliding movement in either direction on the rotational axis C—C of the motor **70**, spindle **71**, and cutter **72**. Such axis intersects the axes A—A and B—B and is horizontally disposed when the machine is in the condition indicated in FIG. 3. Motion of the headstock along the axis C—C is known as depth adjustment. Such adjustment enables the machine operator to control the position of the cutter trace relative to the depth or horizontal thickness of the workpiece.

In order to permit depth adjustment of the headstock, the vertical swivel saddle is formed with a wide radial channel **248** in its outer face (FIGS. 3, 20, and 21). The channel **248** receives a rectangular slide **249** which is fixed to the casing of the motor **70**. The slide **249** is retained in the channel **248** by means of cleats **250** fastened to the face of the vertical swivel saddle **68** (FIGS. 3, 17 18 and 21). The latter may include non-metallic wear plates **251** (FIG. 21).

Power actuation of the headstock depth adjustment is accomplished by means of an electric motor **252** (FIGS. 3, 10, 17, 18 and 29) mounted on a bracket **253** fixed to the vertical swivel saddle **68**. The motor **252** is connected, as by bevel gears **254, 255**, to a feed screw **256** journaled in a hub **257** on the bracket **253** and extending longitudinally of the channel **248**. The feed screw **256** engages a nut **258** fixed at the mouth of a relatively deep clearance socket **259** in the headstock depth slide **249** and when rotated imparts longitudinal sliding motion to the latter. The exposed intermediate portion of the feed screw between the hub **258** and the depth slide is covered by a protective bellows **260** (FIGS. 1, 3 and 18). With the foregoing arrangement, the motor **252** is adapted to shift the headstock **69** on its depth slide **249** anywhere between the retracted position shown in FIGS. 17 and 18, and the extended position indicated in dot-dash lines in FIG. 17, and such motion may occur in either direction along the axis C—C.

Operatively associated with the headstock depth adjustment drive and mechanically coupled thereto are an electric brake type clamp **261** and low and high speed selsyn units **262, 264** (FIGS. 18 and 29).

In order to provide a further adjustment of the cutter to meet the requirements of particular workpieces, an arrangement is interposed between the headstock and the headstock depth slide **249** (FIGS. 18 to 21) to permit offsetting of the cutter relative to the vertical swivel axis A—A. Such offset adjustment is manual in the present instance. It is obtained by means of an adapter plate **265** bolted solidly against the depth slide **249** by means of a series of cap screws **266**. The adapter plate has an upright channel **268** with a gib **269** extending along one side thereof. The channel **268** slidably receives a mounting pad **270** integral with the casing of the headstock motor **70**. The pad **270** has a tapped bore **271** which is engaged by an adjusting screw **272**. The screw **272** is journaled in a bracket **274** fastened to the adapter plate **265** and has a squared upper end **275** for engagement with a wrench or other adjusting tool. The position of the headstock motor **70** relative to the adapter plate **65** and the headstock depth slide **249** may be selectively varied by simply turning the adjusting screw **272**. Once such adjustment has been made, the headstock motor may be clamped in place by tightening mounting bolts **276** which engage spaced apart T-slots **278** in the adapter plate **265** (FIGS. 19, 20 and 21).

COUNTERBALANCING

Provision is made in the machine **50** for counterbalancing the vertically movable members in a novel and effective manner, as illustrated in FIGS. 3, 22, 23 and 24. This is accomplished in part by constructing the vertical saddle **66** in such a manner that its weight, including the parts stationarily fixed thereon, will be approximately equal to the weight of the vertical swivel saddle **68**, head stock **69**, and parts associated therewith, and then mechanically connecting these saddles **66, 68** together by means of a flexible tension element. The foregoing is also accomplished in part by utilizing a single loading means acting on such flexible tension element to counterbalance the combined total weight of the saddles **66, 68** and the parts respectively mounted thereon. In this case, the common counterbalancing means is a hydraulic actuator **280** situated within the column **34** and having its lower end securely anchored to the swivel base **61** as by means of cap screws **281** (FIG. 24).

Referring once more to FIG. 12, which shows the rear side of the vertical saddle **66**, and to FIG. 24, it will be noted that a flexible tension element in the form of a steel cable **282** is fastened to the upper portion of the vertical saddle **66** by means of an anchor fitting **284**. The cable **282** is led upwardly from the vertical saddle and over a guide sheave **285** journaled in a bracket **286** at the top of the column face **176** (FIG. 24). From the sheave **285**, the cable **282** is led over a sheave **288** which is journaled in a bracket **289** fixed to a heavy horizontal plate **290** in the top of the column. The cable passes from the sheave **288** to movable element **291** of the hydraulic actuator, and thence to another sheave **292** also journaled in the bracket **289**. From the sheave **292**, the cable runs over a sheave **293** journaled in the bracket **286**, over a sheave **294** perpendicular thereto which is journaled in bracket **295**, and thence downwardly to an anchor fitting **296**. The latter has a bifurcated lower end which engages a swivel eye **297** projecting radially from the upper end of the vertical swivel saddle **68**. A bolt or other suitable pivotal connection **298** pivotally connects the anchor fitting **296** with the swivel eye **297**.

By reason of the foregoing arrangement, the vertical saddle **66** and vertical swivel saddle **68** not only counterbalance each other but, in addition, their combined weight is most effectively counterbalanced by the hydraulic actuator **280**. The latter operates on pressurized oil from the hydraulic system of the machine.

Provision is made for counterbalancing the combined total weight of the vertical saddle **66** and swivel saddle **68** over the entire range of vertical travel of the vertical saddle **66** while minimizing the stroke required of the movable member **291** of the hydraulic actuator **280**. This is accomplished by resort to a multiple strand loop in the counterbalancing cable **282**. As shown in FIG. 24, a double sheave **299** is journaled in bifurcated upper end **300** of the movable member **291** and an intermediate sheave **301** is journaled in the bracket **289**.

The cable **282** passes from the sheave **288** downwardly and into the first groove of the double sheave **299**, thence passing upwardly over the intermediate sheave **301** and then downwardly again but then into the second groove of sheave **299**. From here the cable is led up over the sheave **292** and, as described earlier herein, ultimately to the vertical swivel saddle **68**.

THE PROFILING TRACER ASSEMBLY

The profiling tracer assembly **74** (FIGS. 1, 3, and 31 to 34), is adapted to control the vertical motion of the saddle **66** along the column **64** and the horizontal motion of the sliding base **59** along the fixed base **58**. When the machine is operating on tracer control, follower **305** of tracer **306** traverses the profile of the template T and this results in various combinations of these two motions, causing the cutter **72** to generate a similar profile in the workpiece. Moreover, such motions may be of appropriate magnitudes and directions to permit the tracer follower **305** and the cutter **72** to generate a trace through 360°.

The profiling tracer assembly **74** comprises an upstanding support column **308** bolted or otherwise rigidly secured to the upper portion of the vertical saddle **66** (FIGS. 11, 31, 32 and 33). The column **308** is fashioned with a pair of spaced apart upstanding guides **309** which slidably support a mounting bracket **310**. The latter may be selectively positioned at various vertical points on the column **308** by means of an adjusting screw **311** and a manually actuated clamp (not shown).

Rigidly fixed to the mounting plate **310** is an arcuate way **312** which carries a tracer swivel saddle **314**. The latter is secured against the face of the arcuate way **312** and guided therealong as for example, by means of bearings **315** (FIGS. 31 and 34) which bear against the curved edges of the way **312**. The tracer swivel saddle **314** has an upstanding lug **316** which is pivotally connected by means of a pin **318** and spacer **319**, with a depending mechanical link **320**. At its lower end, the link **320** is pivotally connected to a lug **321** on the vertical swivel saddle **68**, thus duplicating vertical swiveling motions of the vertical swivel saddle in the tracer swivel saddle **314**. To permit an adjustment in length in the link **320** corresponding to offset adjustment of the headstock **69**, or to bring the swivel saddles **68, 314** into parallel alinement, the link **320** is provided with a turnbuckle **322**.

Mounted radially of the tracer swivel saddle **314** and shiftable along a radial line between an extended and a retracted position is a tracer retraction slide **324**, the latter being shifted by means of a small hydraulic actuator **325** which is connected to the hydraulic system of the machine by means of conduits **326, 328**. The outer extremity of movement of the retraction slide **324** may be selectively varied by means of adjusting screw **329** (FIG. 33). Adjacent its outer end, the retraction slide has mounted thereon a relatively small vertical slide **330** which carries the tracer **306**. The slide **330** may be adjusted along guides **331** by means of hand crank **332**. The hand crank may be used to compensate for the amount of offset that is given to the headstock.

THE SWIVEL TRACER ASSEMBLY

The swivel tracer assembly **75** (FIGS. 1, 3 and 35 to 37) is adapted to control the horizontal and the vertical swiveling motions of the headstock and cutter by controlling the horizontal swiveling motion of the swivel base **61** and the vertical swiveling motion of the vertical swivel saddle **68**. In the present instance, this is accomplished through a pair of template operated rack and pinion tracer units **335**, **336** mounted on the side of the machine remote from the cutter **72**. Each of these tracer units includes a follower **338** which reciprocates a small rack **339**, shown diagrammatically in FIG. 30. The displacements of the rack are transmitted to a gear train via a pinion **340**, and thence to a selsyn control which in this case includes low speed and high speed selsyn units **341** and **342**. These units transmit signals to appropriate controls in the main power and control panel **76** which correspondingly govern the swiveling motors **141** and **214** respectively associated with the swivel base **61** and the vertical swivel saddle **68**.

Referring in greater detail to FIGS. 35, 36 and 37, it will be noted that the swivel tracer assembly **75** is supported by means of a relatively heavy overhanging mounting bracket **345** anchored to the sliding base **59** as by means of cap screws **346**. At its outboard end, the bracket **345** has an upstanding wall **348** which is provided with a pair of vertically spaced, horizontal guide ways **349**, **350**. Mounted in longitudinally spaced relation on the guide ways **349**, **350** are a pair of slides **351** and **352**. Within the limits allowed by the longitudinal dimensions of the parts, the slides **351**, **352** are selectively positionable along the guide ways. Projecting horizontally from the slide **351** is a rigid, box-like frame **354** which carries the tracer unit **335** and a housing **355** which encloses the associated gear train and selsyn units **341**, **342** shown diagrammatically in FIG. 30. For setting-up purposes, the tracer unit **335** may be horizontally and vertically adjustable with respect to the frame **354**. A frame **356**, similar in construction to the frame **354** but somewhat longer, is fixed to the slide **352** and projects outwardly therefrom. The tracer **336** is carried by the frame **356** and its associated selsyn units and gear train are enclosed within housing **358** also carried by the frame **356**. The tracer unit **336** may also have horizontal and vertical adjustments with respect to its frame **356**.

Operatively associated with the tracer units **335**, **336** are control templates **359**, **360** which in the present instance happen to be of the straight line type. The template **359**, associated with the tracer unit **335**, has its top edge formed so as to generate swiveling signals for the swivel base **61**, for example, in properly timed relation to the signals produced by the profiling tracer **306**. By the same token, the template **360** operates the tracer unit **336** and may be contoured to produce swiveling signals for the vertical swivel saddle **68**, also in timed relation to the signals produced by the profiling tracer **306**.

The templates **359**, **360** (FIGS. 1, 3, 4, and 35 to 37) are disposed longitudinally of the fixed base **58** and supported on a cantilever bracket **361** situated on the side of the fixed base remote from the cutter **72**. At longitudinally spaced inervals, the templates **359**, **360** are secured against a spacer block **362** as by means of clamps **364** (FIG. 37). When the templates **359**, **360** and the tracer units **335**, **336** are in properly adjusted, operative position, each template registers with a slot in a corresponding one in a pair of guide head **365**, **366** associated with respective ones of the tracers **335**, **336**. Moreover, as the tracers traverse the templates due to the motion of the sliding base **59** along the fixed base **58**, the projections on the templates will actually enter these slots. Follower **338A** of tracer unit **335** is biased downwardly so as to remain in contact with the upper edge of the template **359** during such traversing movement, this being accomplished by means of a small hydraulic cylinder

368 at the top of the tracer unit **355**. A similar hydraulic cylinder **369** serves to bias follower **338B** into continuous contact with the top of the template **360**.

In order ot provide a so-called "zero adjustment" of the tracers and their respective templates or, in other words, to adjust each tracer into proper phase longitudinally of its associated template, provision is made for precisely locating the tracer slides **351**, **352** along their guide ways **349**, **350**. This is accomplished by manually shifting each of the slides **351**, **352** until its respective tracer unit has been brought into approximate position with respect to the template. The slide is then clamped by tightening a handle **370** provided for this purpose. Final positioning of either slide is then accomplished by means of a micrometer screw which is actuated by a knob **371**, one such knob being located at either end of the mouting bracket **345**.

MODIFIED SWIVEL TRACER ASSEMBLY

The swivel tracer assembly of the machine **50** may be modified so as to operate on "full area template control." This term means that swivel signals are generated throughout a 360° trace of the cutter **72** without necessity for stopping the machine after the first 180° of the trace have been completed and installing a new template for the remainder of the trace. Straight line templates, such as the templates **359**, **360** will provide signals for only 180° of a cutter trace, in other words, only for machining the top half of the workpiece. Swiveling signals for the trace required for the bottom half of the workpiece must then be derived from another straight line template.

Full area template control in the machine **50** may be achieved by mounting the swivel tracer units **335**, **336** and their slides **351**, **352** on a vertically disposed tracer column situated on the sliding base **59** in place of the mounting bracket **345**. The tracer units **335**, **336** and their slides are moved vertically of the tracer column in timed relation with the movements of the vertical saddle **66**. This is accomplished by driving the tracer slides by means of a vertically disposed feed screw in the tracer column, such feed screw being driven synchronously with the elevating screw **190** of the vertical saddle.

The templates for tracers arranged as just described are of the "wrap around" type. They are formed by figuratively "wrapping" a metal band around the profile template T, joining the ends of the band together to form a closed loop, removing the closed loop from the profile template, and then contouring one side edge of the loop to define the desired swiveling signals to be picked up by an associated tracer unit. Instead of being mounted on a bracket like the templates **359**, **360**, the wrap around templates are mounted on a vertical fixture similar to the fixture **51** and situated on the opposite side of the machine from the fixture **51**.

I claim as my invention:

1. A floor type contour milling machine comprising, in combination a relatively long fixed base, a sliding base mounted on said fixed base for reciprocation therealong and having an upper horizontally extending surface, a *generally sector shaped* horizontal swivel base mounted on said upper surface and movable in an arcuate path thereon *about a vertical axis* relative to said sliding base, an upstanding, *susbtantially triangular shaped* column fixed to said swivel base, a vertical saddle mounted on said column for reciprocation vertically thereof, a vertical swivel saddle mounted on said vertical saddle and movable in an arcuate path thereon *about a horizontal axis*, a headstock *including means for receiving a cutter* mounted on said vertical swivel saddle *with said horizontal axis and said vertical axis intersecting and passing through said cutter mounted in the headstock*, a profiling tracer assembly for controlling the reciprocation of said sliding base and of said vertical saddle, and a swivel tracer assembly for controlling the arcuate movement of said swivel base and of said vertical swivel saddle.

2. A floor type contour milling machine comprising the combination of a relatively long fixed base, a sliding base mounted on said fixed base for reciprocation therealong and having an upper horizontally extending surface, a power drive for imparting said reciprocation to said sliding base, a horizontal *generally sector shaped* swivel base mounted on said upper surface and movable in an arcuate path thereon *about a vertical axis* relative to said sliding base, a power drive for imparting arcuate movement to said swivel base, an upstanding column fixed to said swivel base, *said column being substantially triangular in cross section,* a vertical saddle mounted on said column for reciprocation vertically thereof, a power drive for imparting said reciprocation to said vertical saddle, a vertical swivel saddle mounted on said vertical saddle and movable in an arcuate path thereon *about a horizontal axis,* a power drive for imparting arcuate movement to said vertical swivel saddle, a headstock *adapted to receive a cutter* mounted on said swivel saddle *with the cutter passing through the intersection of said horizontal and vertical axes,* a profiling tracer assembly for controlling said power drives of said sliding base and of said vertical saddle, and a swivel tracer assembly for controlling said power drives of said swivel base and of said vertical swivel saddle.

3. A floor type contour milling machine comprising, in combination, a fixed base, a sliding base mounted on said fixed base for reciprocation therealong and having an upper horizontally extending surface, a power drive for imparting said reciprocation to said sliding base, a horizontal *sector shaped* swivel base mounted on said upper surface and movable in an arcuate path thereon *about a vertical axis* relative to said sliding base, a power drive for imparting arcuate movement to said swivel base, an upstanding *substantially triangular shaped* column fixed to said swivel base, a vertical saddle mounted on said column for reciprocation vertically thereof, a power drive for imparting said reciprocation to said vertical saddle, a vertical swivel saddle mounted on said vertical saddle and movable in an arcuate path thereon *about a horizontal axis,* a power drive for imparting arcuate movement to said vertical swivel saddle, a headstock *adapted to receive a cutter* mounted on said vertical swivel saddle *with said cutter passing through the intersection of said horizontal and vertical axis,* a profiling tracer mounted on said vertical saddle and movable bodily therewith, said profiling tracer being adapted to control said power drives of said sliding base and said vertical saddle, and a pair of swivel tracers mounted on said sliding base and movable bodily therewith, one of said swivel tracers being adapted to control said power drive of said swivel base, and the other of said swivel tracers being adapted to control said power drive of said vertical swivel saddle.

4. A floor type contour milling machine comprising, in combination a fixed base, a sliding base mounted for longitudinal sliding motion on said fixed base and having an upper horizontally extending surface, a *generally sector shaped* swivel base mounted for arcuate swiveling motion on said upper surface, an upstanding *substantially triangular shaped* column fixed to said swivel base, a vertical saddle mounted on said column for reciprocating motion vertically thereof, a vertical swivel saddle mounted on said vertical saddle for arcuate swiveling motion thereon, a headstock mounted on said vertical swivel saddle for radial depth adjusting motion relative thereto, power drives for effecting said motions, a profiling tracer assembly for controlling the motions of said sliding base, said vertical saddle, and said headstock, a swivel tracer assembly for controlling the motions of said swivel base and said swivel saddle, and controls interposed between said tracer assemblies and said power drives providing for simultaneous tracer control of any four out of five said motions.

5. In a floor type contour milling machine, the combination of an upright supporting column, *said column being substantially triangular shaped,* a vertical saddle mounted on said column and reciprocable vertically thereof, a vertical swivel saddle mounted on said vertical saddle for arcuate movement relative thereto, a headstock carried by said vertical swivel saddle, a tracer swivel saddle movable bodily with said vertical saddle and also disposed for arcuate movement relative thereto, a tracer unit mounted on said tracer swivel saddle, [and] a mechanical link pivotally connected between said vertical swivel saddle and said tracer swivel saddle for synchronizing the swivel motion of both *and said link including means for adjusting the length thereof for varying the positioning of tracer swivel saddle with respect to said vertical swivel saddle.*

6. In a floor type contour milling machine, the combination comprising an upright *substantially triangular shaped* supporting column, a vertical saddle mounted on said column and reciprocable vertically thereof, a vertical swivel saddle mounted on said vertical saddle for arcuate movement relative thereto, a headstock carried by said vertical swivel saddle, a tracer mounted on said vertical saddle in spaced relation with said headstock and in alinement with a common upright axis, means connecting said tracer with said vertical swivel saddle for swiveling said tracer in unison with the swiveling motion of said vertical swivel saddle, a *generally sector shaped* swivel base supporting said column, and means mounting said swivel base for pivotal movement of itself, said headstock and said tracer about said common upright axis.

7. A floor type contour milling machine comprising, in combination, a relatively long fixed base, a sliding base mounted on said fixed base for reciprocation therealong and having an upper horizontally extending surface, a power drive for imparting said reciprocation to said sliding base, a horizontal *generally sector shaped* swivel base mounted on said upper surface and movable in an arcuate path thereon *about a vertical axis* relative to said sliding base, a power drive for imparting arcuate movement to said swivel base, an upstanding column fixed to said swivel base, a vertical saddle mounted on said column for reciprocation, vertically thereof, a power drive for imparting said reciprocation to said vertical saddle, a vertical swivel saddle mounted on said vertical saddle and movable in an arcuate path thereon, on power drive for imparting arcuate movement to said vertical swivel saddle, a headstock *adapted to receive a cutter* mounted on said vertical swivel saddle *and movable in an arcuate path about a horizontal axis, said horizontal axis intersecting with said vertical axis along said cutter* and a pilot control system including a source of signals for controlling said power drive.

8. In a floor type contour milling machine, the combination comprising, a fixed base, a sliding base reciprocally mounted on said fixed base and having an upper horizontally extending surface, a horizontal *generally sector shaped* swivel base mounted on said upper surface for arcuate movement relative to said sliding base, a *substantially triangular shaped* column fixed to said swivel base, a vertical saddle reciprocally mounted on said column, a vertical swivel saddle mounted on said vertical saddle for arcuate movement relative thereto, a headstock carried by said vertical swivel saddle, power means for moving said saddles and said bases relative to each other, and means including a source of signals for controlling said power means.

9. A floor type contour milling machine comprising, in combination, a relatively long fixed base carrying a pair of laterally spaced horizontal ways defining a runway, a generally rectangular sliding base element mounted on said fixed base for reciproction along said runway and having a substantially horizontal upper surface, said sliding base carrying on its upper surface a pair of spaced arcuate ways, a generally horizontal swivel base element mounted on said arcuate ways and movable in an arcuate path therealong, a pivot shaft on said sliding base posi-

tioned at the geometric center of said arcuate ways, means journaling said swivel base on said shaft for swiveling movement relative to said sliding base and along said arcuate ways, a generally vertical column fixed to said swivel base, a pair of spaced vertical ways secured to and extending along said column, a vertical saddle element mounted on said vertical ways for reciprocation vertically thereof and having a substantially vertical face carrying a pair of spaced arcuate ways, a vertical swivel saddle element mounted on said vertical arcuate ways for movement in an arcuate path relative to said vertical saddle, a pair of vertically spaced horizontally extending parallel guide ways on said vertical swivel saddle, a slide element mounted on said guide ways for reciprocating horizontally thereof, and a power headstock mounted on said slide, means for moving said elements relative to each other to position said headstock, a source of pilot control signals, and means operative in response to signals from said source for controlling the operation of said element moving means.

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