July 24, 1951 E. L. McFERREN 2,561,936

WAY GRINDING MACHINE

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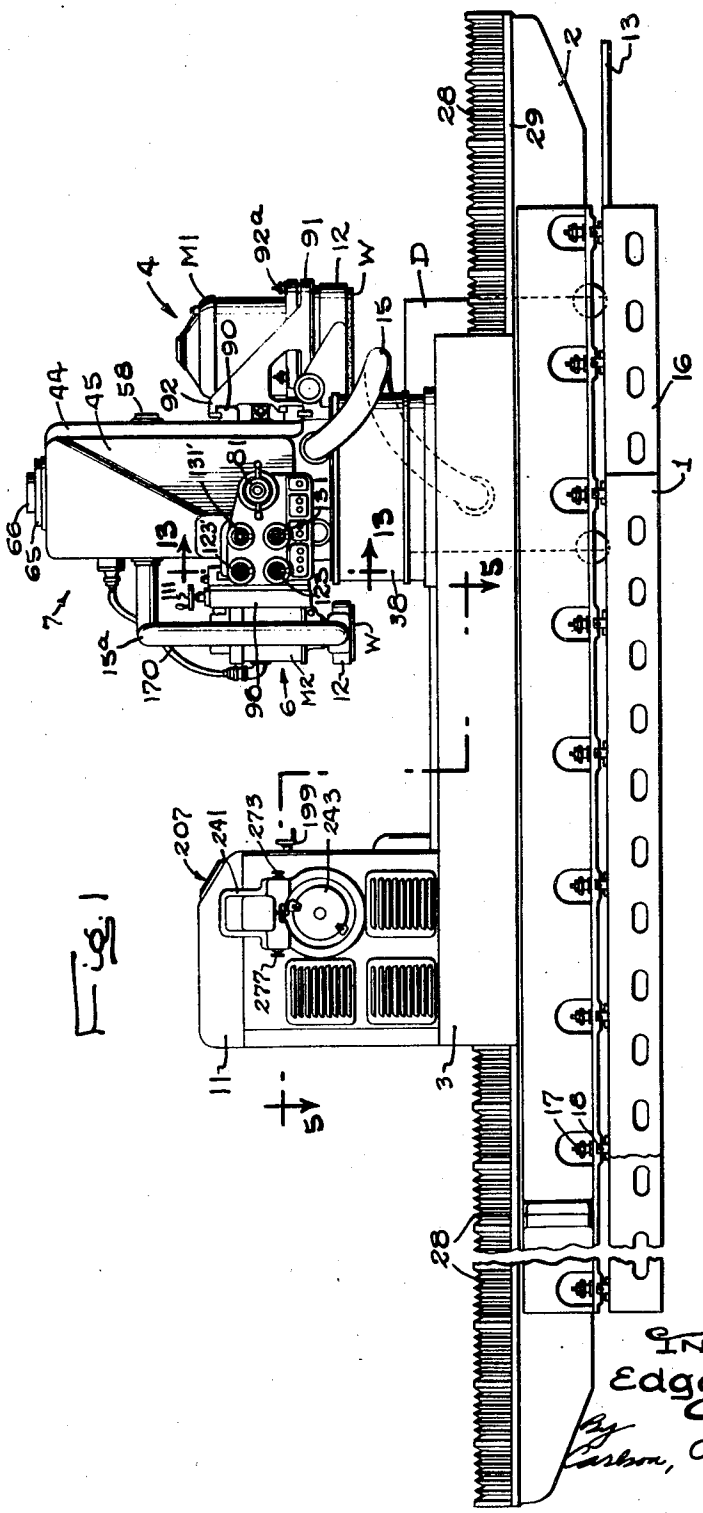


Fig. 1

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WAY GRINDING MACHINE

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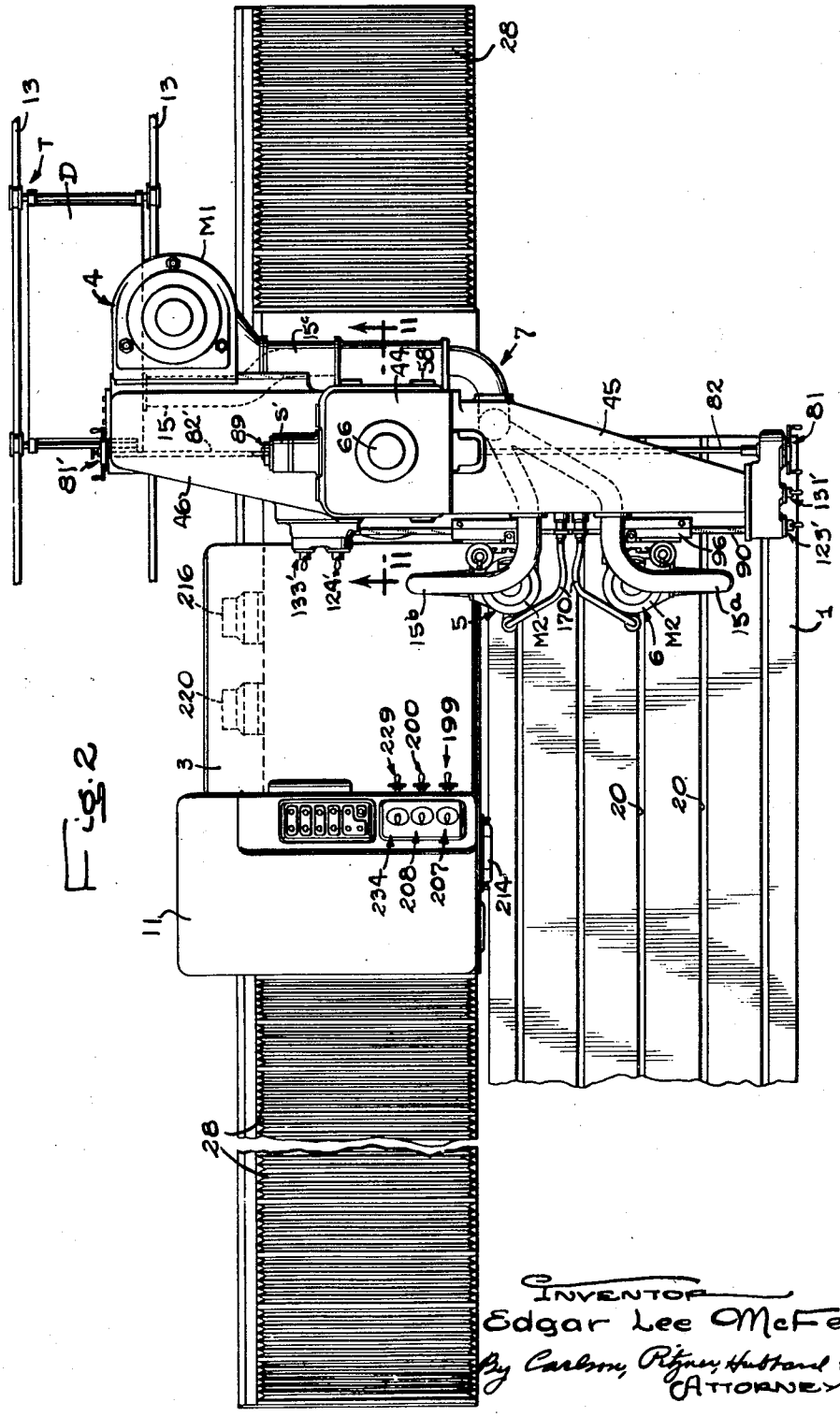


Fig. 2

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WAY GRINDING MACHINE

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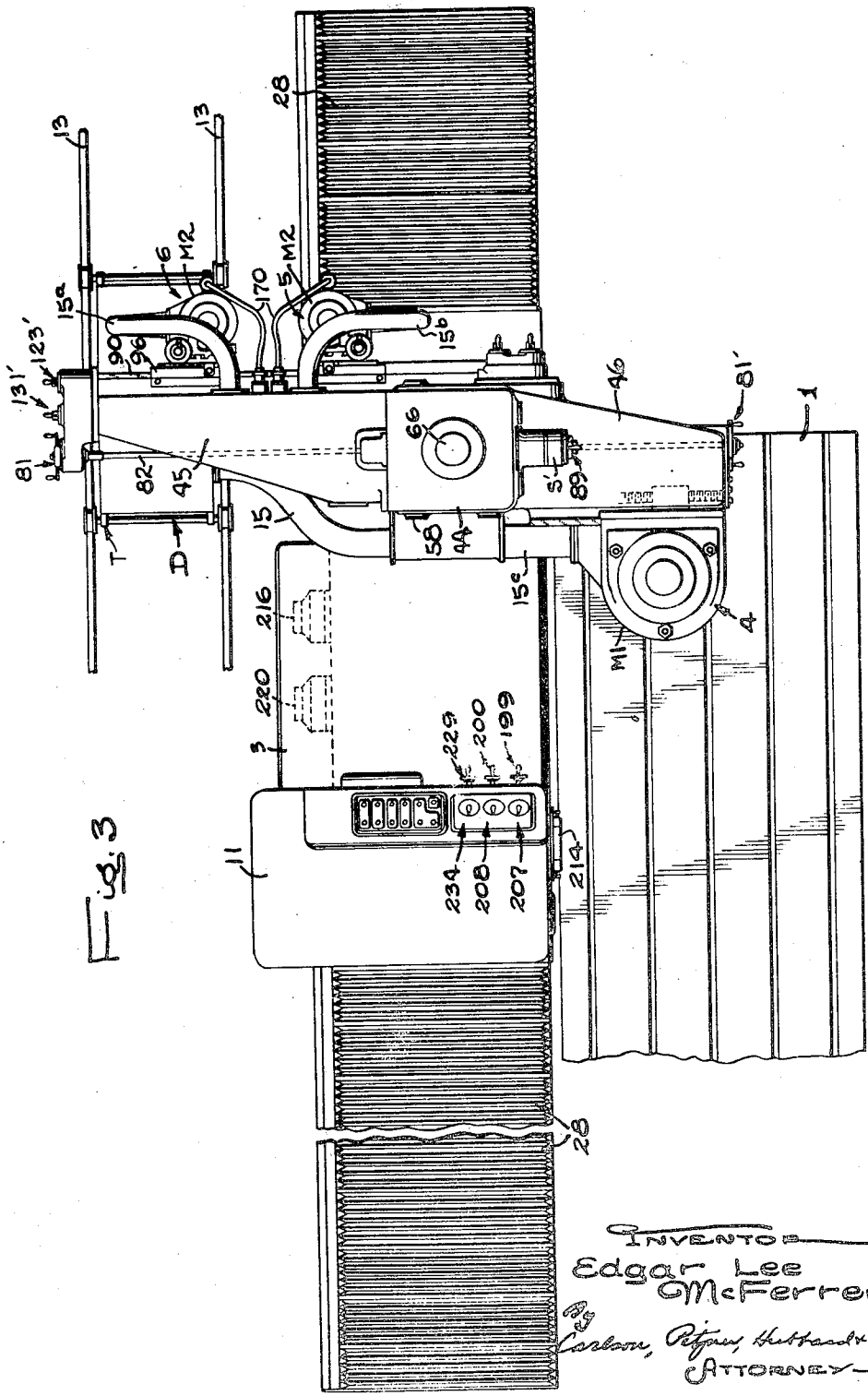


Fig. 3

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WAY GRINDING MACHINE

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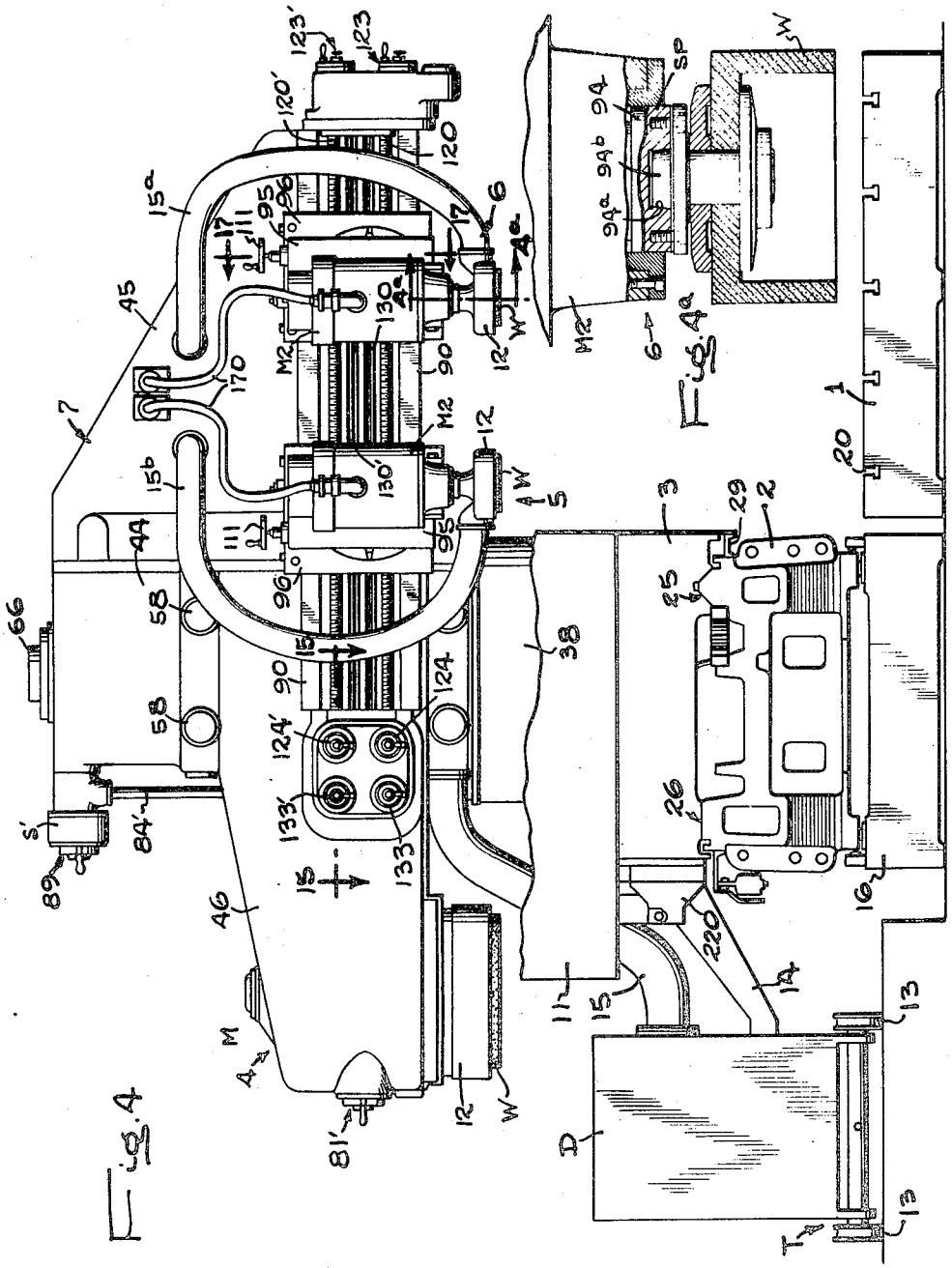


Fig. 4

Fig. 4a

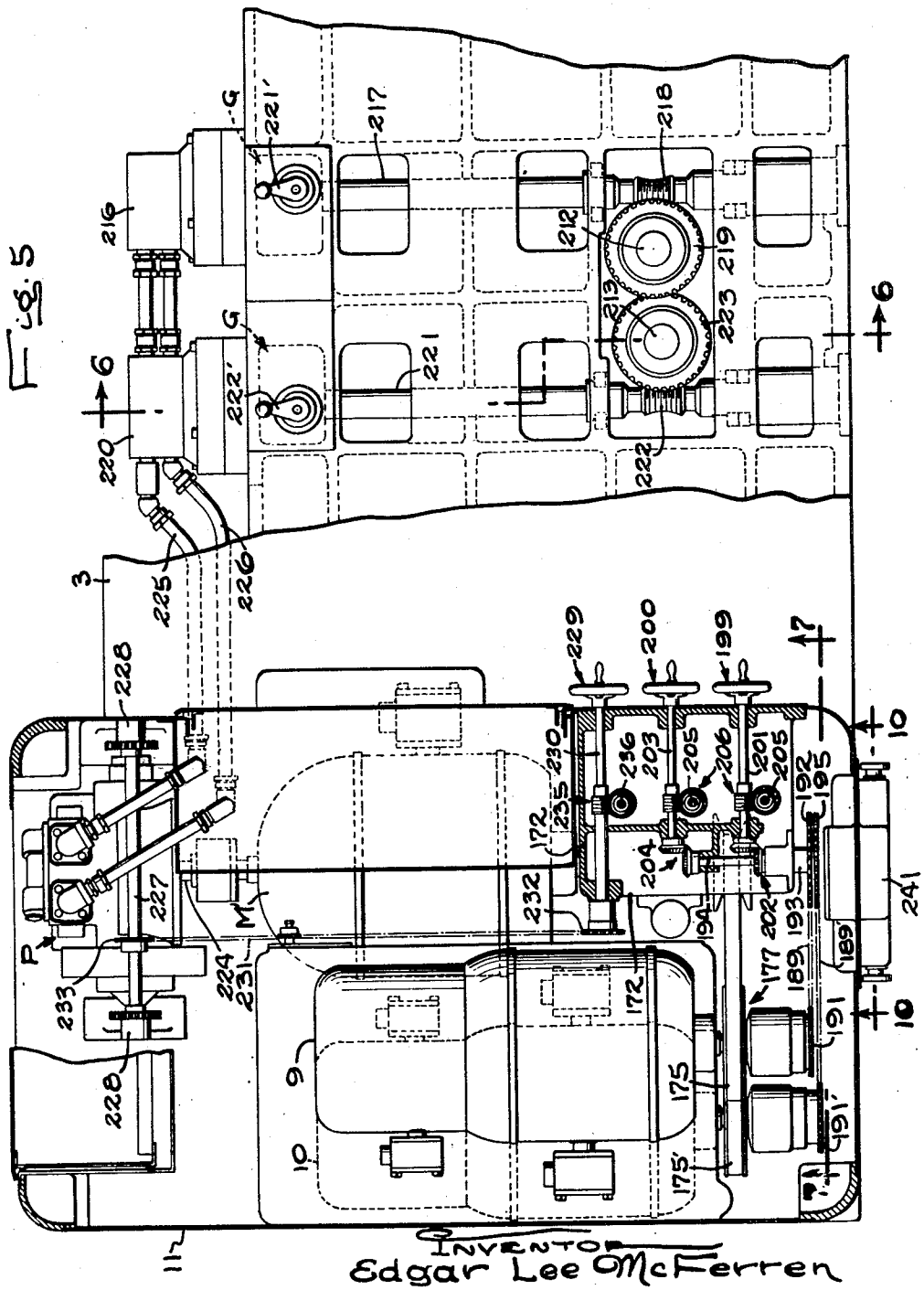
INVENTOR
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WAY GRINDING MACHINE

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Fig. 5



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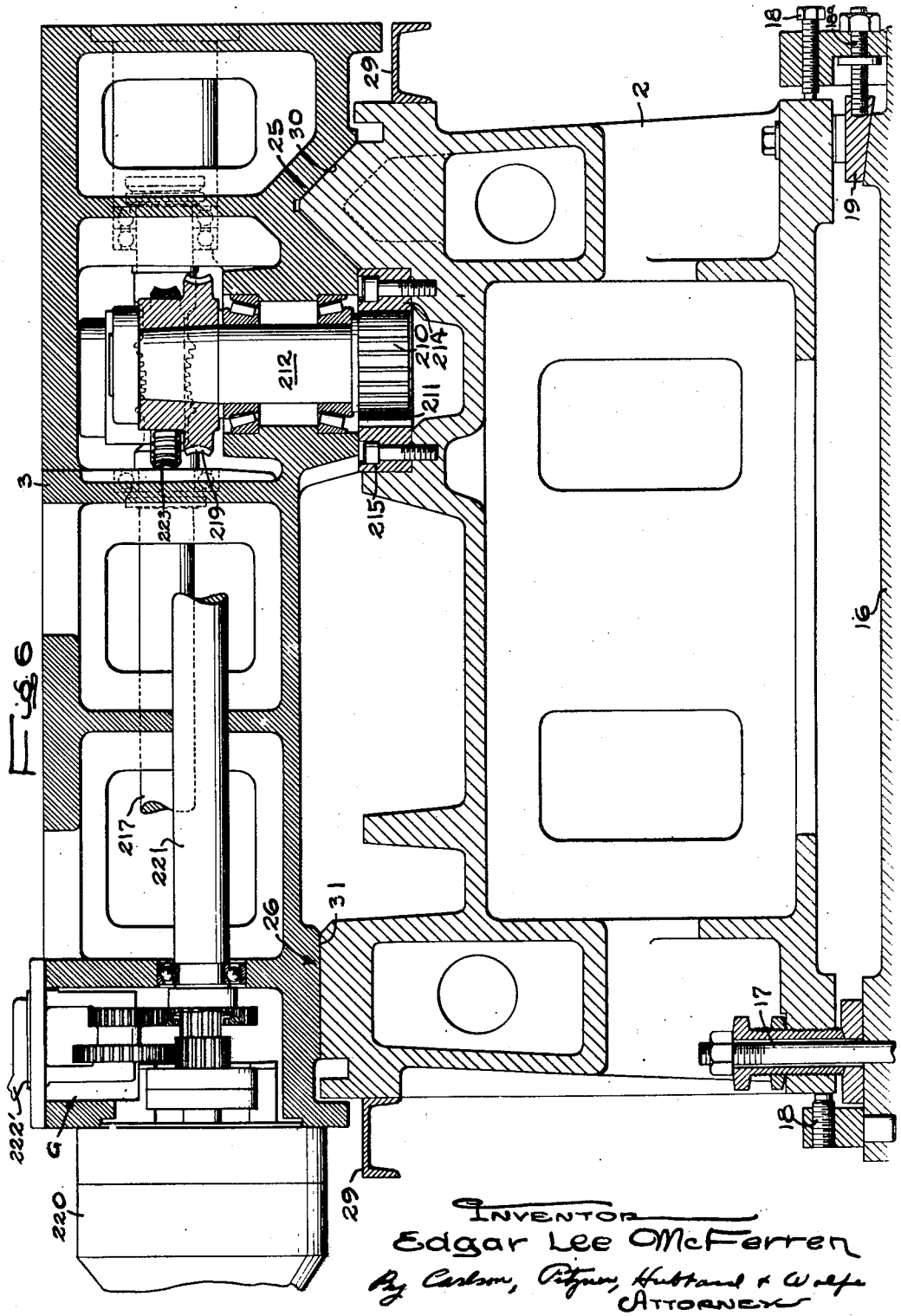


Fig. 6

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WAY GRINDING MACHINE

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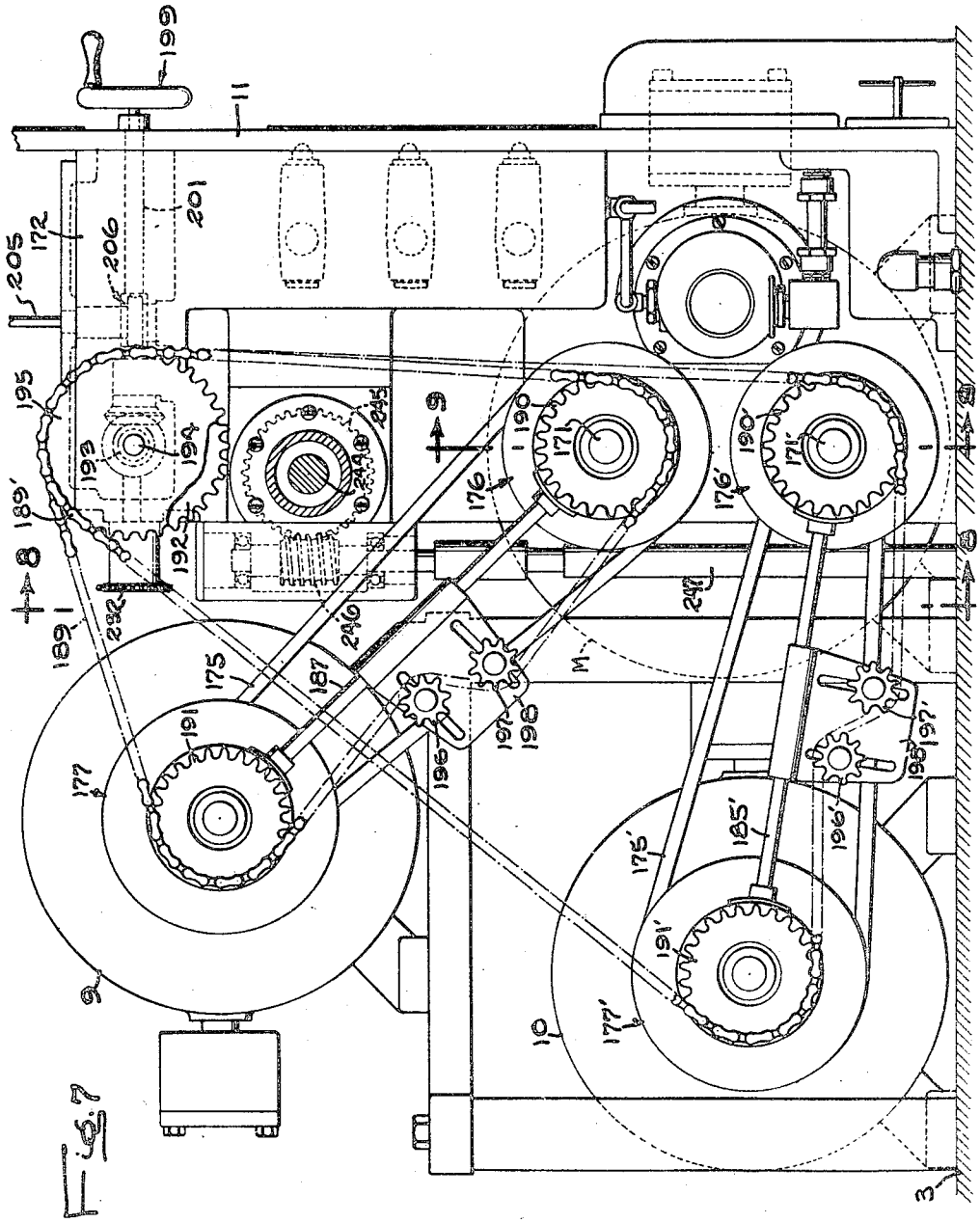


Fig. 7

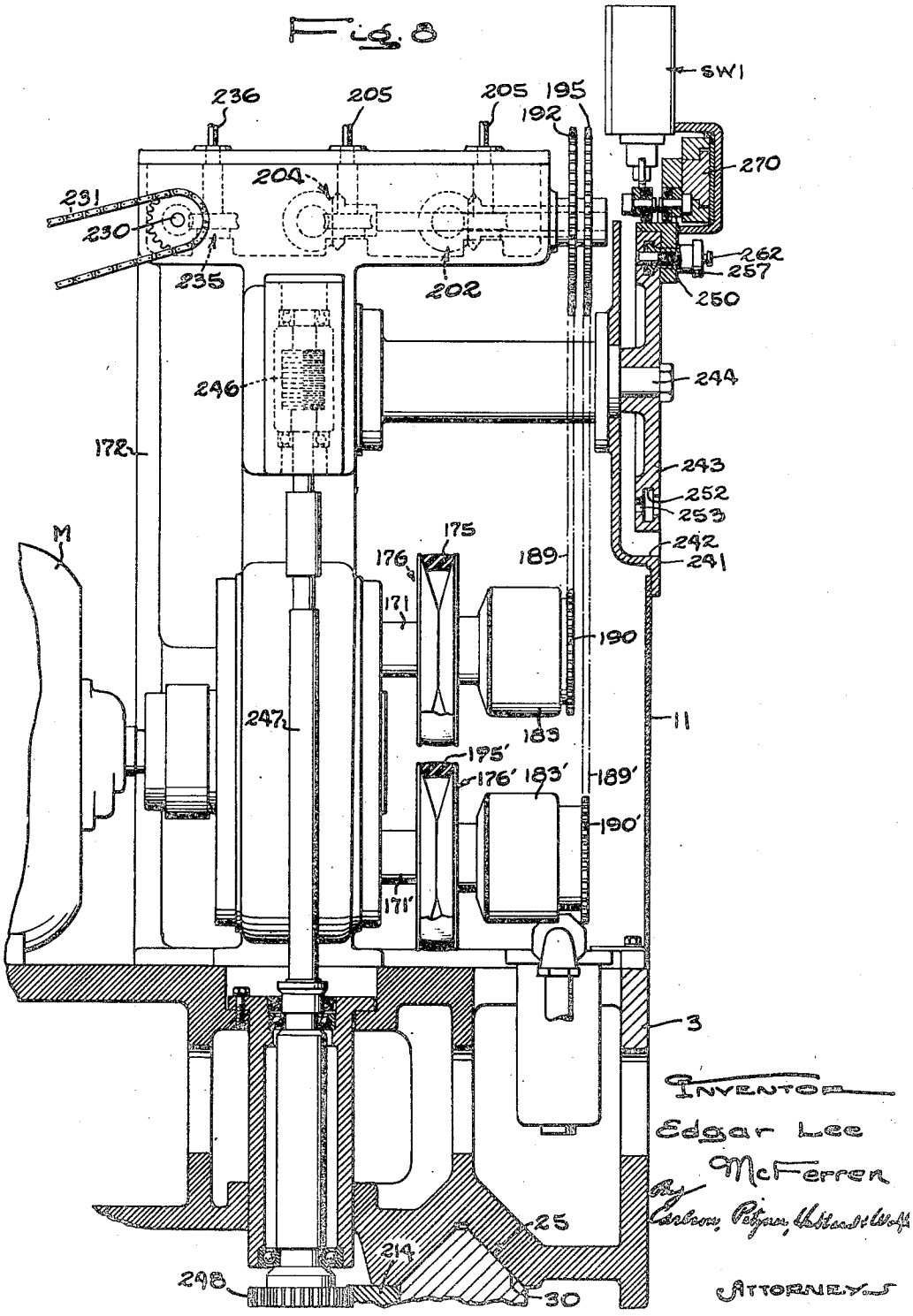
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Fig. 8



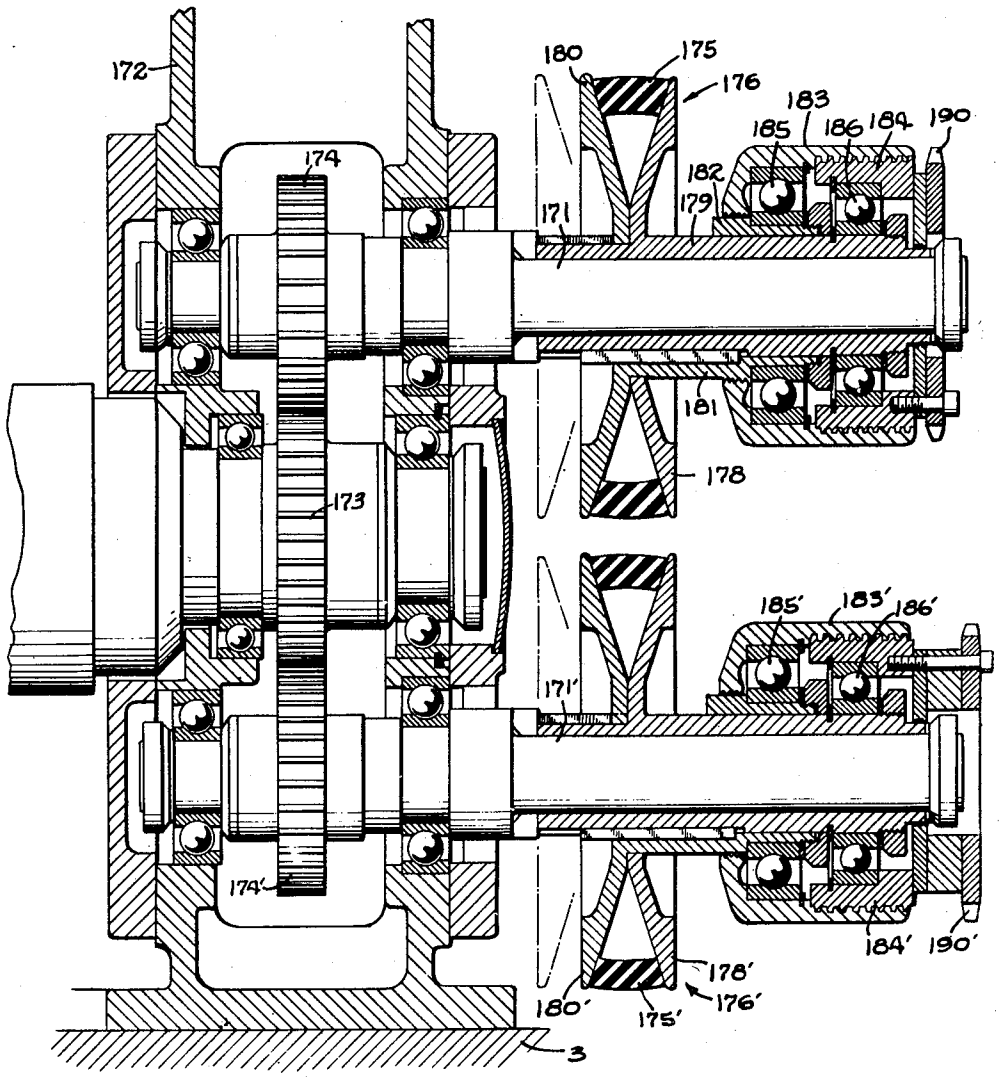
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July 24, 1951 E. L. McFERREN 2,561,936

WAY GRINDING MACHINE

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Fig. 9



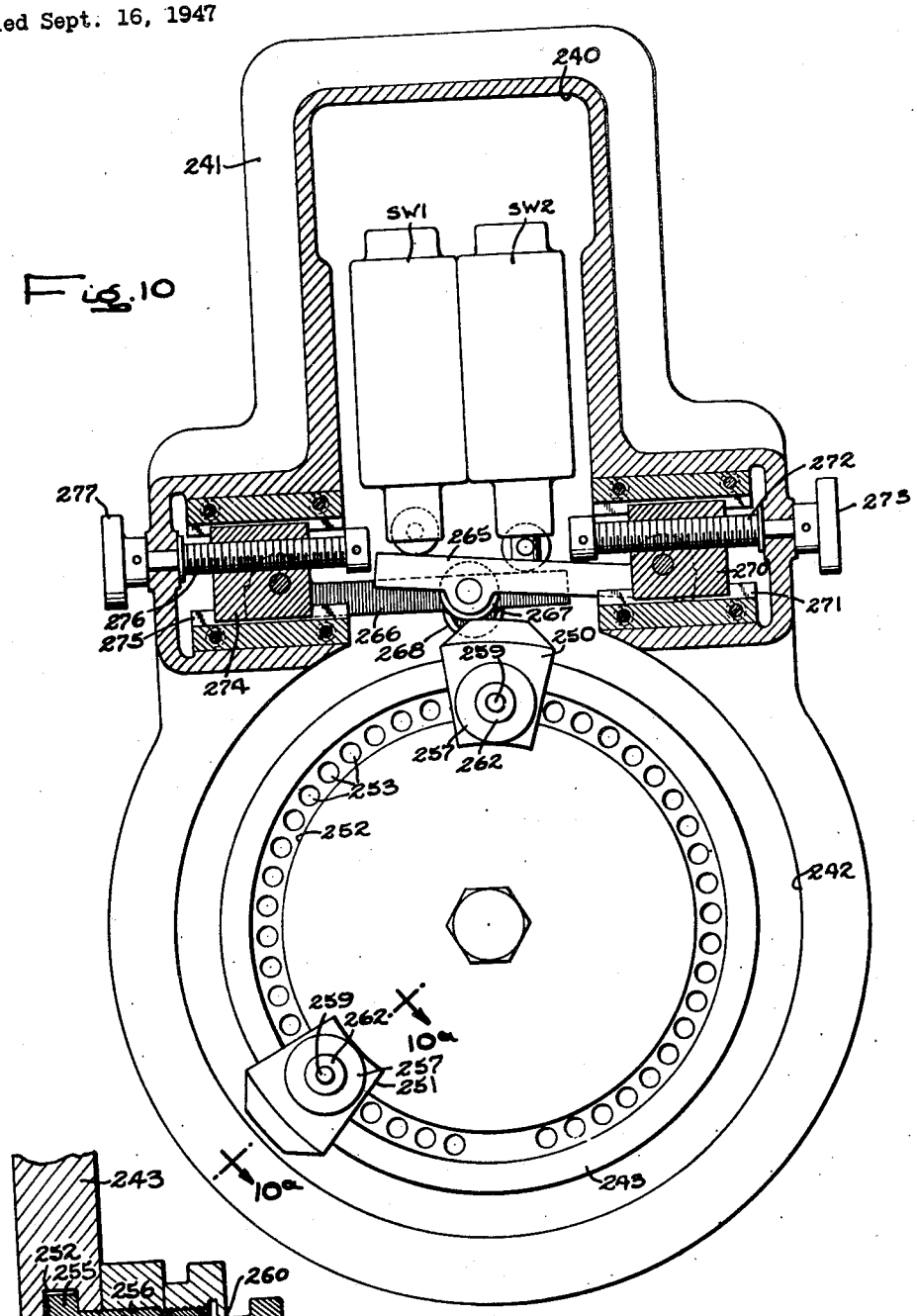
INVENTOR
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Fig. 10



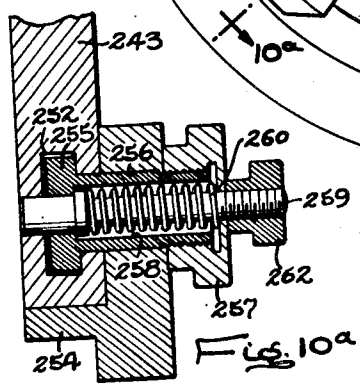


Fig. 10a

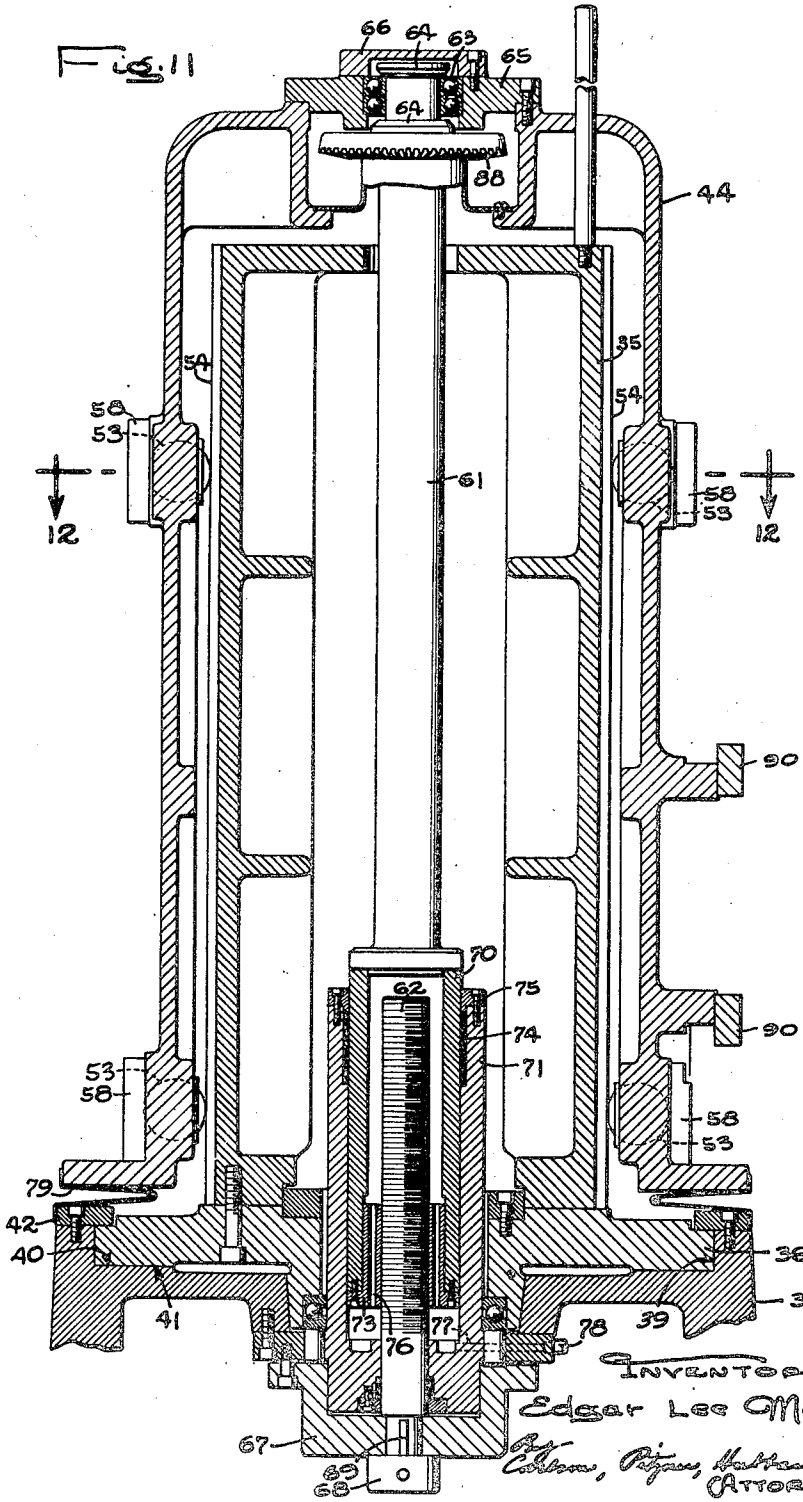
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Fig. 11



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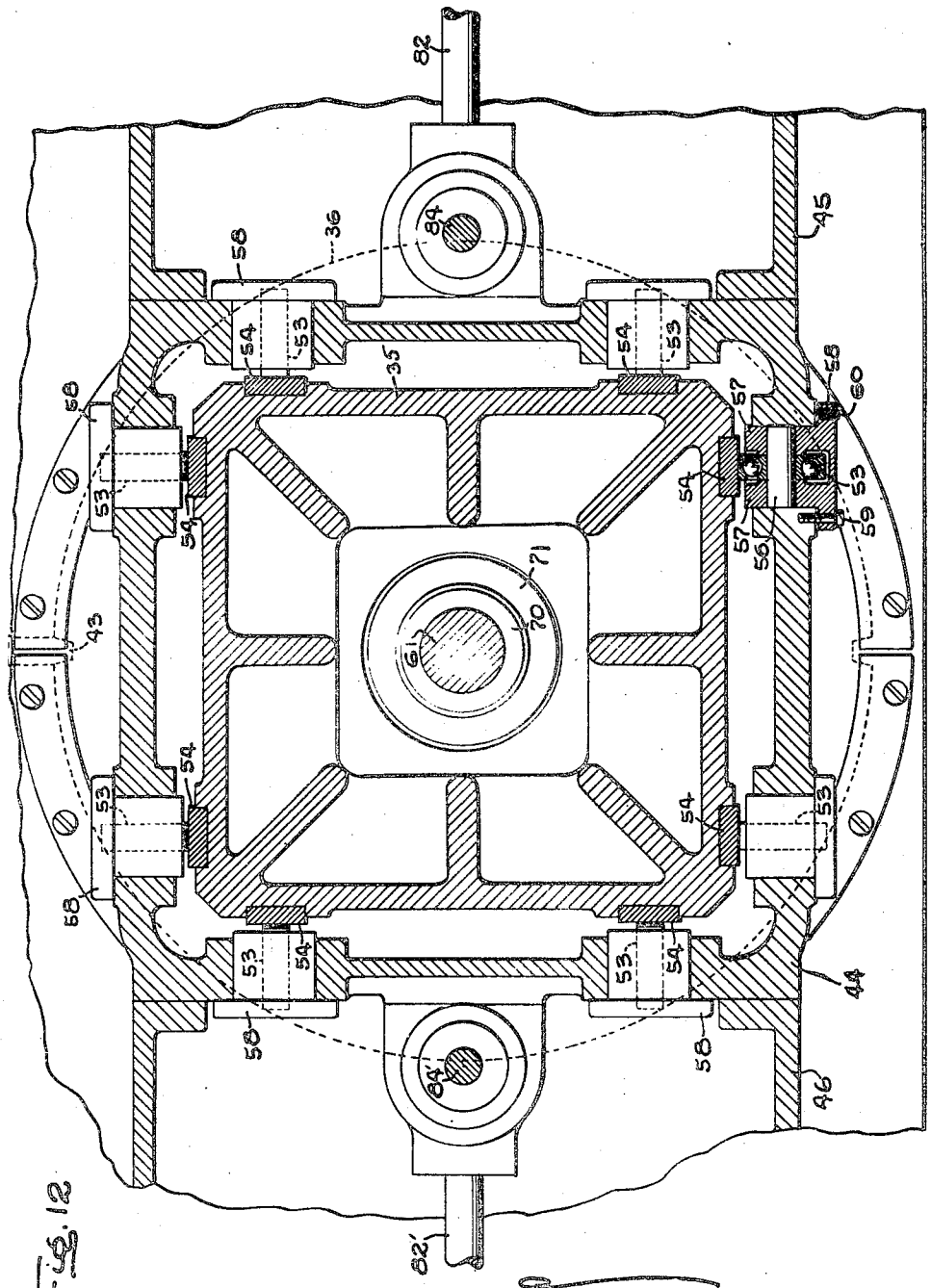


Fig. 12

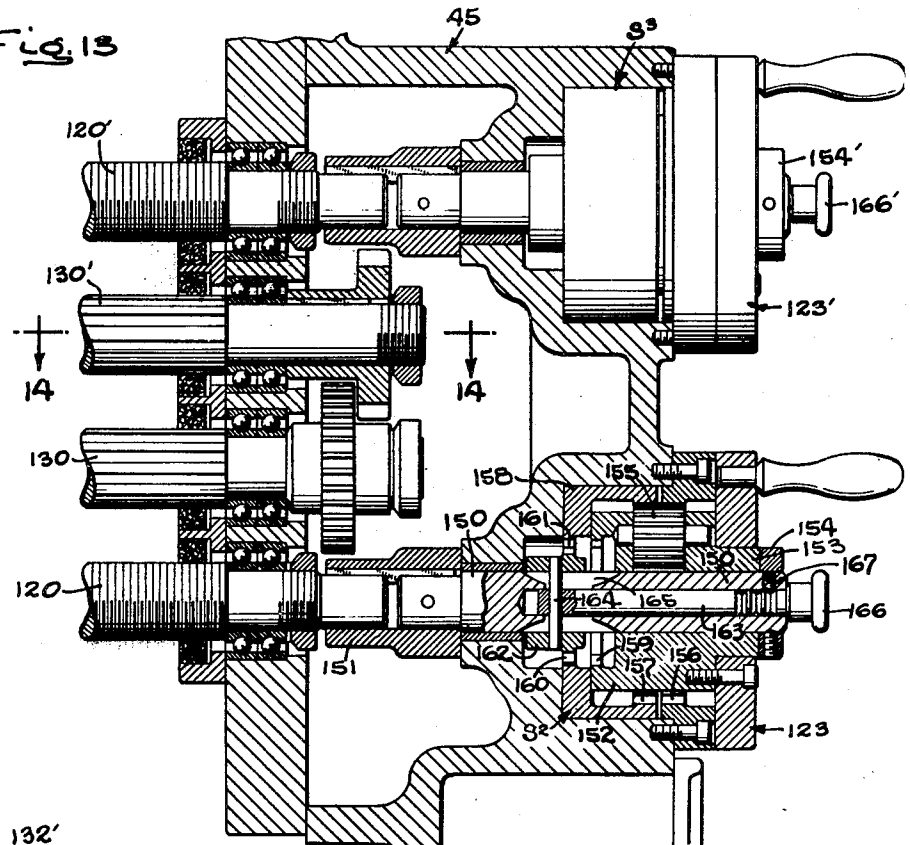
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July 24, 1951 E. L. McFERREN 2,561,936

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Fig. 13



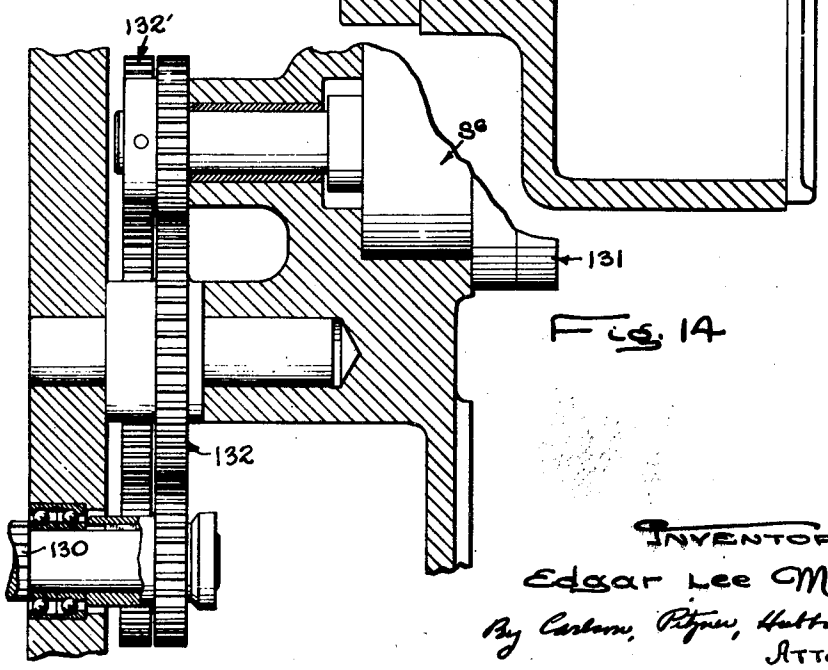


Fig. 14

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WAY GRINDING MACHINE

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Fig. 15

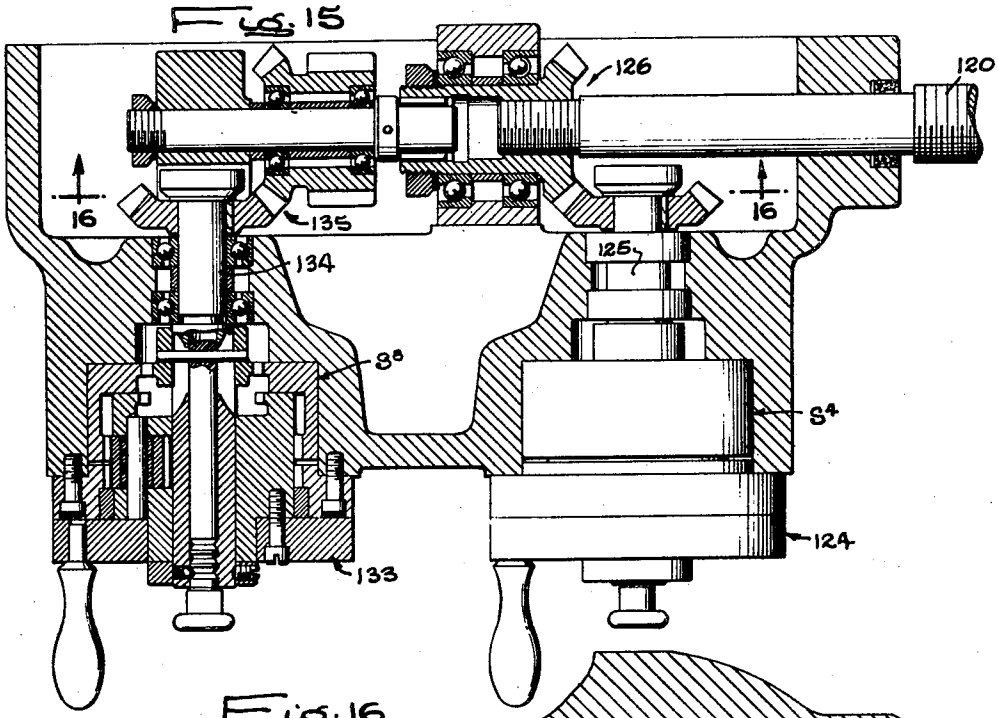
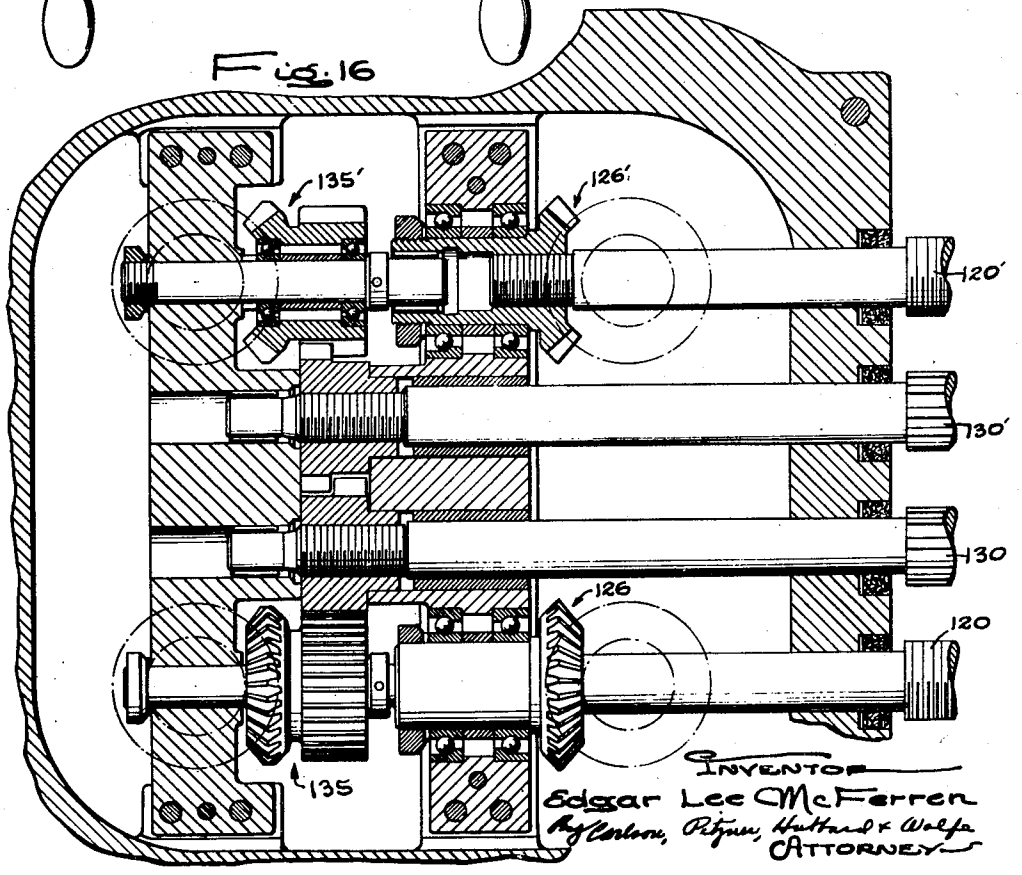


Fig. 16



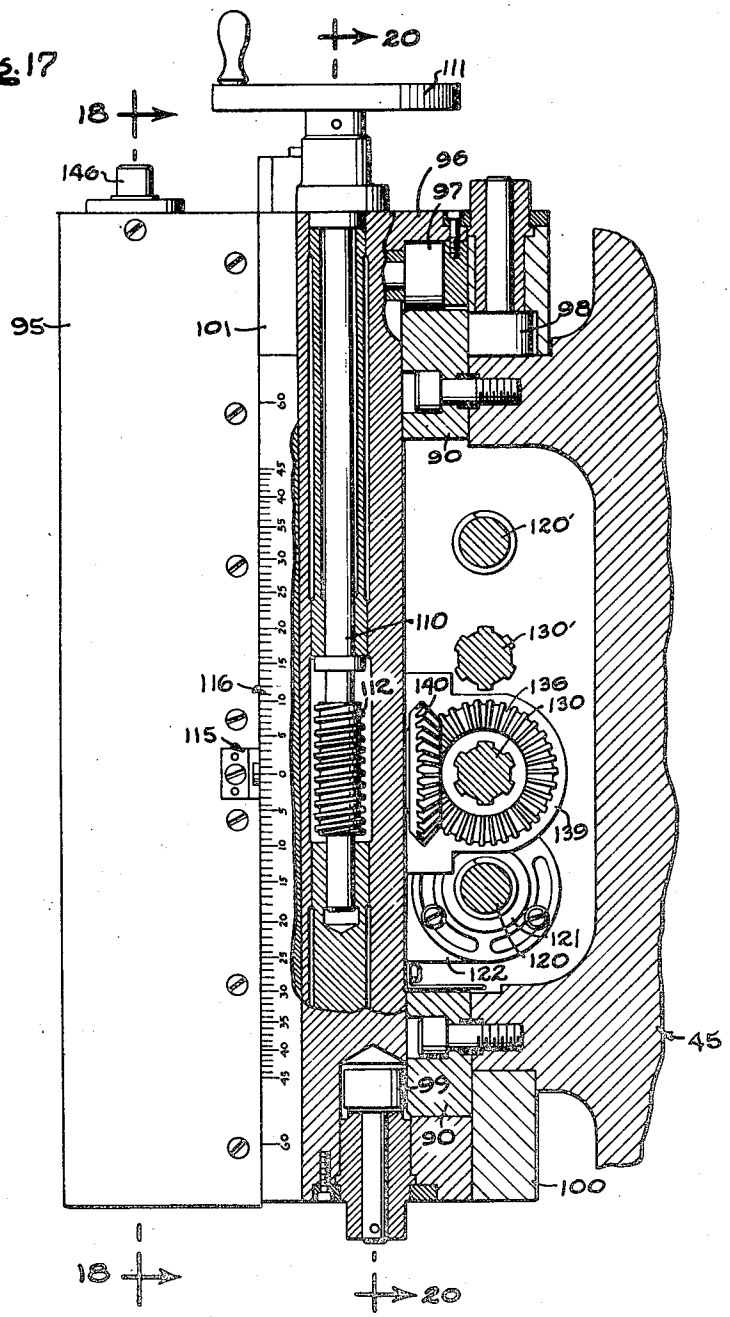
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July 24, 1951 E. L. McFERREN 2,561,936

WAY GRINDING MACHINE

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Fig. 17



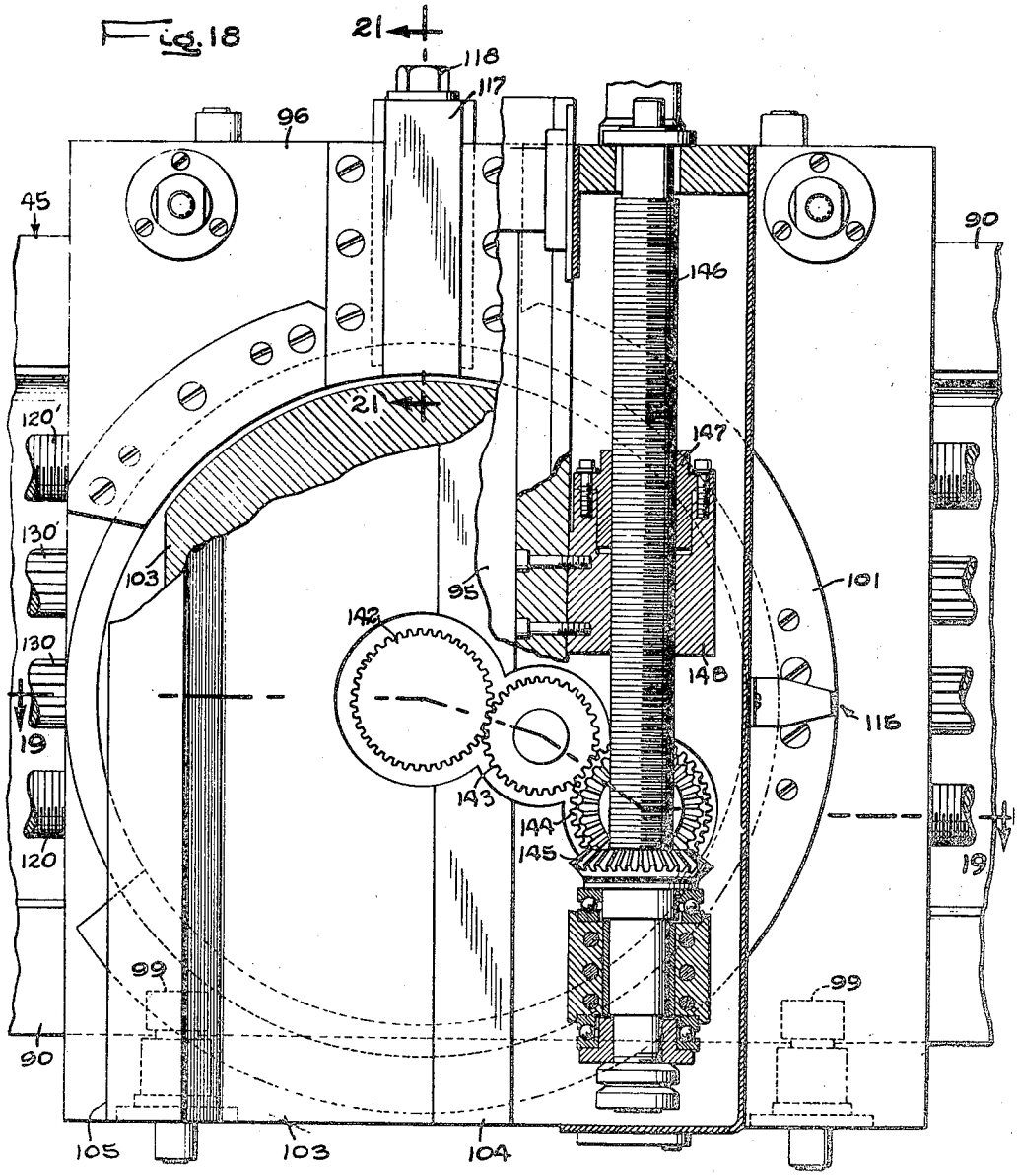
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WAY GRINDING MACHINE

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Fig. 18



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July 24, 1951 E. L. McFERREN 2,561,936

WAY GRINDING MACHINE

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Fig. 19

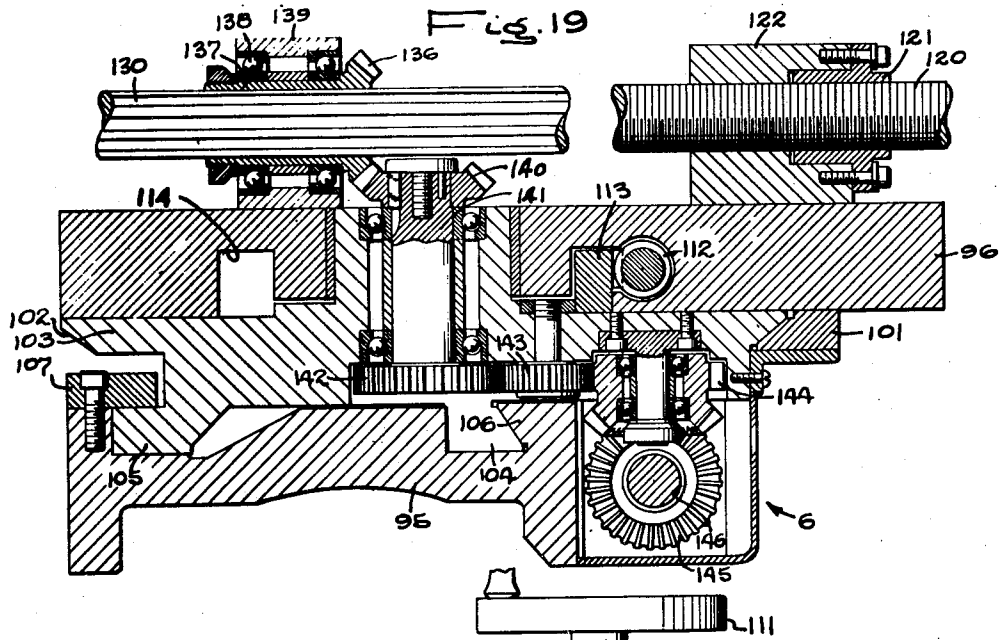


Fig. 20

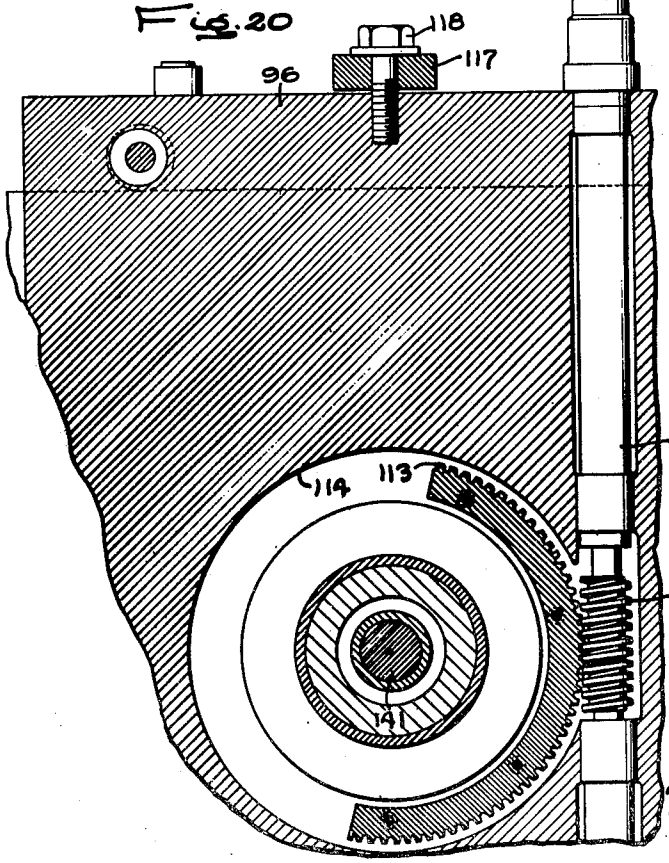
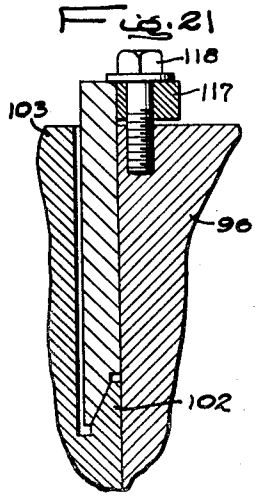


Fig. 21



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WAY GRINDING MACHINE

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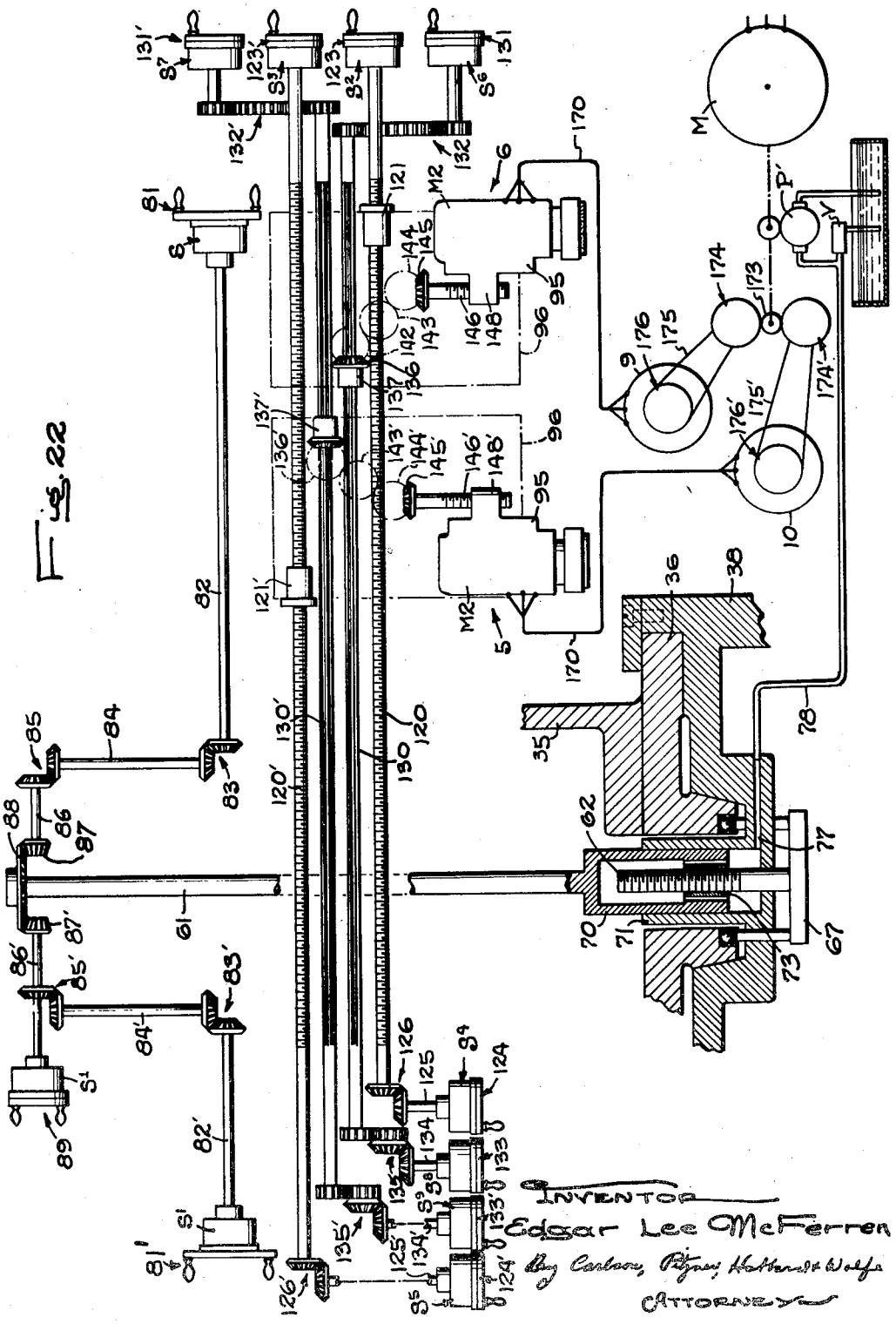


Fig. 22

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2,561,936

UNITED STATES PATENT OFFICE

2,561,936

WAY GRINDING MACHINE

Edgar Lee McFerren, Fond du Lac, Wis., assignor to Giddings & Lewis Machine Tool Company, Fond du Lac, Wis., a corporation of Wisconsin

Application September 16, 1947, Serial No. 774,366

16 Claims. (Cl. 51—3)

1

The invention relates generally to improvements in machine tools and more particularly to machine tools for machining long surfaces such as ways on large machine structures.

One object of the invention is to provide a machine of the above general character capable of finishing the ways of large machine structures economically and with an exceptionally high degree of precision.

Another object is to provide novel variable speed drive and control means for machine toolheads which permits the use of A. C. electric driving motors in the heads and thus facilitates accurate balancing of the same and reduces maintenance costs.

Another object is to provide a machine tool having a vertically movable toolhead supporting structure adjustable by means of a screw and nut mechanism and having novel pressure fluid-actuated means for counterbalancing the weight of the structure so as to relieve the adjusting means of unnecessary strains.

Another object is to provide improved manually operable feed mechanisms for the movable elements of a machine tool.

Still another object is to provide improved mechanism for effecting adjustment of a machine toolhead from a remote point.

A further object is to provide an improved dust collecting system for large machine tools which avoids the use of long flexible conduits for connecting the suction apparatus of the collector with the reciprocating machine part.

Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated and described in the accompanying drawings, in which:

Figure 1 is a front elevational view of a way finishing machine embodying the features of the invention.

Fig. 2 is a plan view of the machine showing the finishing toolheads positioned over the worktable.

Fig. 3 is a plan view of the machine showing the roughing toolhead positioned over the worktable.

Fig. 4 is an end elevational view of the machine with parts broken away to show the details of the toolhead supporting structure.

Fig. 4*a* is a sectional view of the toolhead taken in a vertical plane substantially on the line 4*a*—4*a* of Fig. 4.

Fig. 5 is a fragmentary horizontal sectional view taken in a plane substantially on the line 5—5 of Fig. 1.

2

Fig. 6 is a sectional view taken in a vertical plane on the line 6—6 of Fig. 5.

Fig. 7 is a sectional view taken longitudinally of the machine in a vertical plane substantially on the line 7—7 of Fig. 5.

Fig. 8 is a transverse sectional view taken in a vertical plane substantially on the line 8—8 of Fig. 7.

Fig. 9 is a transverse sectional view taken in a vertical plane substantially on the line 9—9 of Fig. 7.

Fig. 10 is a fragmentary sectional view taken in a horizontal plane substantially on the line 10—10 of Fig. 5.

Fig. 10*a* is an enlarged sectional view taken on the line 10*a*—10*a* of Fig. 10 showing details of the dog clamp.

Fig. 11 is a sectional view through the column and toolhead supporting structure taken in a horizontal plane substantially on the line 11—11 of Fig. 2.

Fig. 12 is a transverse sectional view through the column and toolhead supporting structure taken in a horizontal plane substantially on the line 12—12 of Fig. 11.

Fig. 13 is a sectional view through the toolhead supporting structure taken in a vertical plane substantially on the line 13—13 of Fig. 1.

Fig. 14 is a sectional view taken in a horizontal plane substantially on the line 14—14 of Fig. 13.

Fig. 15 is a sectional view through the toolhead supporting structure taken in a horizontal plane substantially on the line 15—15 of Fig. 4.

Fig. 16 is a sectional view taken in a horizontal plane substantially on the line 16—16 of Fig. 15.

Fig. 17 is a sectional view taken in a vertical plane substantially on the line 17—17 of Fig. 4.

Fig. 18 is a sectional view taken in a vertical plane substantially on the line 18—18 of Fig. 17.

Fig. 19 is a sectional view taken in a horizontal plane substantially on the line 19—19 of Fig. 18.

Fig. 20 is a sectional view taken in a vertical plane substantially on the line 20—20 of Fig. 17.

Fig. 21 is a fragmentary sectional view taken on the line 21—21 of Fig. 18.

Fig. 22 is a diagrammatic view showing the controls for the toolheads, the columns and the frequency changers.

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

alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

By way of illustration, the invention has been shown as incorporated in a machine for finishing the ways of large machine tool structures, in this instance by grinding operations. As herein shown, the machine comprises a floor level work supporting table 1 arranged at one side of an elongated bed 2 upon which a carriage or saddle 3 is supported for reciprocation in a plane parallel to the work supporting surface of the table. The saddle 3 serves as a support for the tools required to perform the finishing operations on the work, the tools being traversed over the work by reciprocation of the saddle.

As the exemplary machine is intended for grinding operations, it is equipped with grinding wheels preferably carried by motorized toolheads. To enable the work to be both rough and finish ground in a single setting, the machine is equipped with separate toolheads for performing such operations, in this instance, a single heavy-duty toolhead 4 for rough grinding and a pair of precision toolheads 5 and 6 for finish grinding. The toolheads are adapted to be supported at opposite ends of a crossrail structure 7 which in turn is mounted on the saddle 3 so that it may be rotated about a vertical axis to position either the roughing toolhead 4 or the finishing toolheads 5 and 6 above the worktable 1 as required.

Provision is also made for adjusting the rail structure 7 vertically so as to properly associate the toolheads with the work, and each toolhead is individually adjustable to regulate the depth of cut, and, in the case of the toolheads 5 and 6, to determine the angle of the finished surface.

To facilitate accurate balancing of the toolheads and to reduce upkeep costs, the heads are powered by A. C. electric motors. Maximum flexibility is attained and the operating range of the machine is materially increased by providing variable speed A. C. motors for the finishing toolheads 6 and 6, with individual variable speed generators 9 and 10 (Fig. 7) supplying power for the respective motors. The generators 9 and 10 are separately driven through variable speed drives from a common A. C. motor M which additionally supplies power for reciprocating the saddle 3. In the exemplary machine, the motor M and the generators 9 and 10 are mounted on the saddle 3 and enclosed in a suitable housing 11.

Suitable adjusting mechanisms are provided for setting up the machine and for regulating its actions when in operation. These mechanisms are particularly designed for ease and accuracy of operation, and are located for convenient access by the machine attendant, whereby the time and effort required in the initial set up of the machine is materially reduced and its control and operation are greatly facilitated.

Provision is also made for collecting the dust and grinding chips produced in the operation of the machine, thus assisting materially in maintaining the accuracy of the finished surfaces. The dust collecting system includes a suction type dust collector D, which may be of any preferred construction, having suitable connections with hoods 12 enclosing the grinding wheels of each of the toolheads. To avoid the use of long flexible conduits, the dust collector D is mounted on a wheeled truck T movable along a track 13 in timed relation to the reciprocation of the saddle 3. Such movements of the dust collector are effected, in this instance, by a rigid arm 14 extending between the dust collector and the saddle. Operative connections between the dust collector and the hoods 12 are provided by a main duct 15 extending from the collector to the rail structure 7. Branch conduits 15a, 15b and 15c on and in the rail structure connect the main conduit with the hoods for the respective toolheads.

Referring more in detail to the drawings, the bed 2 is preferably of rigid box-type construction and is securely anchored to a subbase 16 (Figs. 1, 4 and 6) as by hold-down bolts 17. The subbase 16, which may be conveniently made in sections bolted together to provide a continuous member extending the full length of the bed, is set on and grouted to a concrete foundation. Positioning screws 18 (Fig. 6) coacting with the sides of the bed 2 and leveling screws 18a coacting through wedges 19 are provided on the subbase for lining up the bed thereon.

To facilitate placement of the work, the table 1 is preferably constructed in the form of a floor plate adapted to be mounted on the machine foundation at one side of the subbase 16 and at substantially the same level, that is, at floor level. T-slots 20 are provided in the upper face of the table for securing the work in place.

Referring now to Figs. 4 and 6 of the drawings, the bed 2 is formed on the top with spaced parallel longitudinal ways 25 and 26 for supporting and guiding the saddle 3. In the exemplary machine, the ways 25 and 26 are formed along the marginal edges of the bed 2, one way 25 being a guiding V-way, preferably inverted, and the other way 26 being a flat supporting way. The top surface of the bed and particularly the ways 25 and 26 are enclosed and protected against the entry of grinding chips or other foreign matter by suitable way guards 28. To enable them to perform their enclosing function in all positions of the saddle 3, the guards are made in the form of accordion bellows attached at opposite ends to the ends of the bed 2 and saddle 3. Brackets 29 extending longitudinally of the bed and projecting laterally at opposite sides thereof provide sliding support for the way guards.

As herein shown, the saddle 3 comprises a generally rectangular casting of heavy box-type construction. Ways 30 and 31 on its underside are complemental to the ways 25 and 26 and coact with the latter to support and guide the saddle in its reciprocation on the bed 2.

For supporting the rail structure 7, the saddle 3 has at one end an upright column 35 (Figs. 11 and 12), herein shown as an elongated casting of rectangular cross section having a circular base plate 36 secured to its lower end. To permit rotation of the tool supporting rail structure 7 so that either the roughing or finishing toolheads may be swung over the worktable, the base plate 36 is mounted in a swivel base 38 bolted to or otherwise rigidly secured to the saddle 3. The base 38 is formed with an upwardly opening recess 39 for the reception of the plate 36 and an annular bearing surface 40 is provided within the recess for coaction with a complemental bearing surface 41 formed on the underside of the plate. An annular retaining ring 42 bolted to the swivel base and overlying the marginal edge portion of the plate retains the latter in place. A locking pin 43 (Fig. 12) engageable in either of two circumferentially spaced notches in the base plate 36 holds the column in either of its two adjusted positions.

In its preferred form, the rail structure 7 comprises a body portion 44 having rigid arms 45 and 46 projecting at opposite sides. The body 44 is a hollow rectangular casting adapted to fit over the column 35 in telescoping relation. For maintaining the rail structure rigid with the column while permitting vertical adjustment of the same, guide rollers 53 are mounted on the four inner faces of the body 44 for cooperation with vertically disposed guide surfaces formed on the opposed faces of the column. In the particular machine illustrated, four of the rollers 53 are provided on each face of the body, the rollers being arranged in pairs adjacent opposite edges of the face with the rollers of each pair spaced apart vertically for cooperation with one of the vertical guide surfaces of the column. The guide surfaces in this instance are formed by hardened steel bars 54 fixed to the outer faces of the column in any preferred manner.

The rollers 53 preferably comprise conventional antifriction bearings. To provide for lining up the rail structure 7 on the column 35 the rollers are mounted for adjustment toward or from their associated guide rails 54. To this end, each of the rollers 53 is journaled on a shaft 56 carried between a pair of spaced lugs 57 projecting from the inner side of a mounting plate 58. The lugs and roller are received with a slidable fit in an aperture in the wall of the body 44, and the assembly is secured to the body by means of screws 59 extending through the mounting plate 58. The shaft 56 is located so that the roller projects beyond the inner ends of the lugs 57 for engagement with the guide bar 54. The extent of each projection with respect to the body 44 is determined by a series of adjusting screws 60 threaded into the plate 58 and bearing against the outer wall of the body 44. By turning the screw 60 in or out, together with appropriate manipulation of the screws 59, the roller 53 may thus be shifted transversely of its axis either toward or from the associated guide bar. As the rollers 53 are adjustable independently, the tool supporting structure may thus be lined up on the column very easily and appropriate adjustments may be made from time to time to compensate for wear.

While the rollers 53 hold the rail structure 7 in alinement laterally with the column 35, support for the structure is provided by a shaft 61 (Fig. 11) rotatably anchored at its upper end to the structure and having a threaded connection at its lower end with a screw 62 nonrotatably fixed to the swivel base 38. As herein shown, the shaft 61 is anchored to the rail structure by means of antifriction thrust bearings 63 confined between spaced shoulders or thrust collars 64 adjacent the upper end of the shaft. The bearings 63 are seated in a recess in a bearing plate 65 bolted or otherwise fixed to the top of the body 44 of the rail structure. A cap 66 secured to the top of the plate holds the bearings in place. The shaft 61 is therefore freely rotatable, but is movable longitudinally only with the rail structure.

For securing the screw 62 in fixed position, the lower end portion of the screw, which is of reduced diameter, is inserted through an aperture in a cap member 67 secured to the base 38. A collar 68 pinned to the projecting end of the screw prevents its withdrawal from the aperture and a key 69 holds it against rotation therein. With this arrangement, rotation of

the shaft 61 relative to the screw is effective to raise or lower the rail structure, and the tool heads mounted thereon.

To relieve the weight on the threaded connection between the shaft 61 and the screw 62 and thereby reduce the effort required for manual adjustment, provision is made for exerting an upward thrust on the lower end of the shaft to substantially counterbalance the weight of the rail structure. For this purpose the shaft is provided at its lower end with a hollow cylindrical enlargement 70 adapted to work as a piston in a cylinder 71 carried by the base 38. The enlargement 70 is arranged coaxially about the screw 62, and is fitted at its lower end with a nut 73 which, in this instance, provides the threaded connection with the screw 62.

The cylinder 71, which is closed at its lower end, is preferably dimensioned to receive the piston enlargement 70 with a snug sliding fit and a packing 74 held in place by a gland 75 prevents leakage of fluid therebetween. Openings 76 in the nut 73 provide communication between the interior of the piston enlargement and the lower end of the cylinder. Pressure fluid introduced into the closed end of the cylinder is therefore effective to exert an upward thrust on the piston enlargement. Provision is made for introducing pressure fluid such as oil into the cylinder by way of an inlet port 77 in the lower end of the cylinder, which may be connected by a conduit 78 with a suitable source of oil under pressure as, for example, a pump P' utilized to supply lubricant to the machine ways. A relay valve V serves to maintain the pressure of the oil at the value required to produce the desired counterbalancing action.

The bearing surfaces within the swivel base 38 and interior of the rail body 44 are protected against the entry of foreign material by an extensible guard 79 interposed between the base and the lower end of the body, as shown in Fig. 11. The guard may be of any suitable type, such as an accordion bellows, capable of accommodating itself to the various adjusted positions of the rail structure on the column 35.

Manually operable means is provided at conveniently located stations, as, for example, at the ends of the rail structure 7 and on the body 44 thereof for rotating the shaft 61 to effect the vertical adjustments of the rail structure and the toolheads carried thereby. Thus, at the end of the rail formed by the arm 45 there is a handwheel 81 coupled through a speed change mechanism S, described in detail hereinafter, with a horizontal shaft 82 which extends longitudinally through the arm and is connected by gears 83 with a vertical shaft 84 journaled in bearings carried by the body 44, as shown in Fig. 12. The vertical shaft 84 is connected by gears 85 with a short horizontal shaft 86 journaled on the rail body 44 and having a bevel gear 87 meshing with a bevel gear 88 keyed to the upper end of the adjusting shaft 61.

A similar handwheel 81' mounted on the arm 46 of the rail structure is connected with the bevel gear 88 through similar shafts and gearing 82', 83', 84', 85', 86' and 87'. In this instance the shaft 86' is extended through one wall of the rail body 44 and is coupled by a speed changer S' with a handwheel 89 supported on the rail structure as shown in Fig. 4 so as to be readily accessible to the attendant while standing on the saddle 3. By turning any one of the three

handwheels, the shaft 61 is rotated and the rail structure 7 is thus raised or lowered as required.

For supporting the toolheads 4, 5 and 6 on the rail structure 7, the arms 45 and 46 are provided on one side with spaced horizontal ways 90 (Figs. 2–4). Preferably, the ways on the respective arms are faced oppositely so that the toolheads occupy the same relative positions with respect to the column 35 when the rail structure is turned to either the roughing or the finishing position.

The toolheads 4, 5 and 6 may be of any preferred construction and, as herein shown, are of the type in which the tool is directly driven by the head motor. In accordance with the invention, the tool such as a grinding wheel W is mounted on a flanged spindle SP (Fig. 4*a*) removably secured to the motor shaft as by machine screws threaded into a flange 94 on the motor shaft. To facilitate accurate alinement of the spindle SP with the motor shaft, the latter is formed at one end with an axially disposed tapering recess 94*a* for the reception of a complementally tapered projection 94*b* on the inner end of the spindie. The spindle is thus automatically alined with the motor shaft when it is secured in place thereon. Moreover, spindles may be readily interchanged for the accommodation of different types of grinding wheels.

The toolhead 4 has a driving motor M1 (Fig. 1) and is supported with its associated grinding wheel W in a vertical position on a bracket 91 carried by a base 92 slidably mounted on the ways 90 of the arm 46. Adjustment of the motor on the bracket is effected through the medium of adjusting screws 92*a*.

The toolheads 5 and 6 are alike in construction, each having a motor M2 and a grinding wheel W. As these toolheads must produce an accurately finished surface on the work, a wider range of adjustment and greater precision in effecting such adjustment is desirable. The motor M2 is accordingly mounted on a slide 95 (Figs. 18 and 19) which, in turn, is swivel mounted on a base 96 supported and guided on the ways 90 of the arm 45.

As best shown in Figs. 17 and 18, the base 96 is generally rectangular in form and is provided at its upper edge with supporting rollers 97 and retaining rollers 98 cooperating respectively with the upper and rear faces of the bar forming the upper way 90. Rollers 99 journaled on the base 96 adjacent its lower edge engage the front face of the lower way 90 to reduce the frictional drag thereon. A retaining bar 100 secured to the base extends over the way 90 to retain the base in firm engagement with the ways.

Secured to the front face of the base 96 is a segmental member 101 having its inner edge portion undercut to form a dovetailed way for an annular way element 102 formed on the rear face of a swivel member 103. The front face of the member 103 is formed to provide spaced parallel ways 104, 105 (Fig. 19) for the slide 95. As herein shown, the way 104 is undercut for dovetailed engagement with a complemental way 106 on the slide. The way 105 is shaped to provide both front and rear bearing surfaces, the latter for cooperation with a retaining plate 107 fixed on the slide.

Means is provided for rotating the swivel member 103 so as to vary the angular position of the toolhead mounted thereon. The rotating means, as shown in Figs. 17, 19 and 20, includes a vertically disposed shaft 110 journaled in the base 96 and having at its upper end a handwheel 111 by which it may be rotated manually. A worm 112 fixed on or integral with the shaft is adapted to engage a segmental worm gear 113 (Figs. 19 and 20) secured to the rear face of the swivel member 103 and received in an annular slot or recess 114 in the adjacent face of the base 96. The worm gear, as shown in Fig. 20, provides for rotation of the swivel member through an arc of approximately 180°, but it will be understood that provision may be made for a greater or lesser range of rotation if desired.

To facilitate angular adjustment of the toolhead, the swivel member 103 is provided with a vernier scale 115 cooperating with a graduated scale 116 on the base. For locking the head in adjusted position, a generally L-shaped locking member 117 is arranged with one leg supported and guided for vertical movement on the front face of the base 96 and having its end portion beveled for cooperation with the way element 102, as shown in Fig. 21. The other leg of the locking member 117 is extended over the base 96 for the reception of a machine screw 118 which is threaded into the base so that the locking member may be drawn into locking engagement with the way element of the swivel member. The swivel member with the toolhead mounted thereon is then held rigid in its adjusted position.

Means is provided whereby the finishing toolheads 5 and 6 may be traversed manually along the ways 90 of the rail structure or adjusted manually transversely of the ways. The means provided for this purpose is arranged for access at two different positions, as, for example, for access by the attendant when standing adjacent the worktable 1 and also accessible when the attendant is riding the saddle 3. The initial set up of the machine and its control while in operation are thus greatly facilitated.

For traversing the toolheads on the ways 90, feed screws 120 and 120′ (Figs. 4, 16 and 22) are rotatably anchored in the arm 45 between the ways 90 and parallel thereto, the feed screws coacting respectively with nuts 121 and 121′ rigid with the heads 5 and 6. As shown in Fig. 19, the nut 121 is carried by a bracket 122 projecting from the rear face of the base 96 upon which the toolhead 6 is mounted. The nut 121′ is similarly mounted on the base 96 for the companion toolhead 5. Similar traversing means may be provided on the arm 46 and toolhead 4 for traversing that head on its ways as indicated in broken lines in Fig. 3.

Mounted on the outer end of the arm 45 are a pair of handwheels 123, 123′ (Figs. 1, 13 and 22) drivingly coupled with the feed screws 120 and 120′ by speed changers S^2 and S^3, respectively. Similar handwheels 124, 124′ (Figs. 4, 15 and 22) are mounted on the side face of the arm 45 adjacent the inner end of the ways 90. The latter handwheels are coupled by speed reducers S^4 and S^5, short transverse shafts 125, 125′ and gear sets 126, 126′ with the opposite ends of the feed screws 120 and 120′. Accordingly, by appropriate manipulation of the handwheels at either control position, the feed screws may be rotated to move the toolheads 5 and 6 along the ways 90 in either direction.

For translating the toolheads 5 and 6 on their respective bases, a pair of splined shafts 130 and 130′ are rotatably supported on the rail 45 parallel to the feed screws 120 and 120′ and, in this instance, between the screws. Handwheels 131,

131' mounted on the outer end of the arm 45 alongside the handwheels 123, 123' are drivingly coupled with the shafts by speed reducers S^6, S^7 and gear sets 132 and 132' (Figs. 13, 14 and 22). Similar handwheels 133, 133' mounted on the side of the arm adjacent the inner end of the ways 90 and alongside the handwheels 124, 124' are coupled with the opposite ends of the shafts 130, 130' by speed reducers S^8, S^9, transverse shafts 134, 134' and gear sets 135, 135'. The splined shafts may thus be rotated manually from either of the two control stations.

Each of the toolheads 5 and 6 is provided with feed mechanism driven from the respective splined shafts 130, 130' to traverse the toolhead along the ways provided on the swivel member 103 on which the head is mounted. As these mechanisms are alike, a description of one will suffice, reference being had to Figs. 17–19 of the drawings.

As best shown in Fig. 19, the driving connection between the shaft 130 and the traverse mechanism of the toolhead 6 includes a gear 136 having an internally splined hub 137 engaging the shaft. The hub is confined against axial movement and is rotatably supported, in this instance by antifriction bearings 138, in a bracket 139 projecting from the rear face of the base 96. The gear 136 is a bevel gear and meshes with a similar gear 140 fast on a shaft 141 journaled in the swivel member 103 and having its axis coincident with the axis of the member. The shaft 141 carries a pinion 142 which through an idler 143 drives a cluster gear 144 journaled on the base 96. The cluster gear has a bevel gear element which meshes with a bevel gear 145 keyed to a feed screw 146 rotatably anchored on the swivel member 103 and in threaded engagement with a nut 147 carried by a bracket 148 attached to and projecting from one side of the slide 95 upon which the toolhead is mounted. The arrangement of the gearing is such that the driving connection between the splined shaft and the feed screw is effectively maintained in all angular positions of the swivel member, thus permitting adjustment of the toolheads from the two control positions at all times.

The speed changers S associated with the feed screws and adjusting shafts above described are alike in construction. Each provides a connection in either of two speed ranges between the screw or shaft and the associated handwheel by which either a large or a small increment rotation may be imparted thereto upon rotation of the handwheel through a predetermined angle. This permits the machine element to be shifted rapidly to an approximate position and then at a much slower rate and with greater precision to an accurately predetermined operating position.

The speed changers S—S^9 are all alike and a description of one will therefore suffice. As a matter of convenience, the speed changer S^2 interposed between the feed screw 120 and its associated handwheel 123 will be described in detail. Referring to Fig. 13 of the drawings, the speed changer comprises a shaft 150 disposed coaxially of the screw 120 and drivingly connected therewith as by coupling sleeve 151. Rotatably mounted on the shaft 150 adjacent its outer end is a sleeve member 152 which is rigidly secured to the inner face of the handwheel 123 and which has a hub portion 153 of reduced diameter received in a central aperture in the handwheel. A collar 154 fixed on the outer end of the shaft and bearing against the adjacent end of the hub 153 holds the sleeve member and the handwheel in place on the shaft.

Journaled in the body portion of the sleeve member 152 with its axis parallel to the shaft 150 is a wide-faced pinion 155 meshing with a pair of coaxially disposed internal gears 156 and 157 of the same pitch diameter but having different numbers of teeth. The gear 156 is stationarily supported on the end wall of the arm 45, while the gear 157 is formed on a cup-shaped member 158 rotatably supported in a recess in said end wall. Upon rotation of the handwheel 123 the member 158 is thus rotated at a rate determined by the difference in the number of teeth on the gears 156 and 157. In practice it has been found satisfactory to provide forty-nine teeth on the fixed gear 156 and fifty teeth on the rotatable gear 157. With this arrangement a complete revolution of the handwheel 123 will advance the gear 157 and the member 158 through one-fiftieth of a revolution.

Provision is made for coupling the shaft 150 selectively either directly with the sleeve member 152 or with the cup member 158, or for interrupting both connections. For this purpose the members are formed with annular sets of clutch teeth 159 and 160 engageable alternately with the external clutch teeth formed on a sleeve-like clutch member 162 mounted on the shaft 150 for sliding movement axially thereof. Shifting of the clutch member is effected by means of a shifter rod 163 slidable in an axial bore in the outer end of the shaft 150 and operatively connected with the clutch member 162 by a cross pin 164, the shaft 150 being formed with a diametrical slot 165 to accommodate the axial movements of the pin. A knob 166 on the outer end of the shifter rod permits convenient manual manipulation of the same. A spring-pressed detent 167 carried, in this instance, by the collar 154 coacts with circumferential grooves in the shifter rod to hold the clutch member in either of three set positions, that is, in engagement with either the member 152 or the member 158, or in a central neutral position.

It will be evident that when the feed screw 120 is clutched directly to the member 152, rotation of the handwheel will impart relatively rapid movements to the toolhead 6. Alternatively, when the feed screw is clutched to the member 158 the movement imparted to the toolhead per revolution of the handwheel will be exceedingly small. Accurate adjustments of the toolhead may thus be made. These same considerations apply, of course, to the other feed screws and adjusting shafts with which the speed changer S is associated.

As indicated heretofore, the toolheads 5 and 6 are equipped with A. C. motors, and to provide for regulating their speeds in accordance with the requirements of different jobs, power is supplied to the motors by separate variable speed changers 9 and 10 by way of cables 170. The generators are driven by the motor M through individual variable speed drive mechanisms. Referring to Figs. 7–9 of the drawings, the drive mechanisms are alike, that driving the generator 9 comprising a drive shaft 171 journaled on a frame 172 mounted on the saddle 3 and enclosed by the housing 11. The shaft 171 is driven at a constant speed by the motor M through the medium of a pinion 173 on the motor shaft meshing with a gear 174 on the shaft 171. The companion generator 10 is driven by similar mechanism with

corresponding parts designated by primed reference characters.

The drive shaft 171 is connected in driving relation with the generator 9 by a V-belt 175 running over split pulleys 176 and 177 respectively keyed to the drive shaft and the shaft of the generator. The pulleys 176 and 177 and their adjusting mechanisms are similar and a description of one will therefore suffice. As shown in Fig. 9, the pulley 176 comprises a side member or flange 178 rigid with a sleeve 179 keyed to the shaft 171 and secured against longitudinal movement on the shaft. An opposed side member or flange 180 is keyed to an extension of the sleeve 179 and is slidable axially thereon through a limited range. Flange 180 is connected by a link 181 extending through an aperture in the flange 178 with a collar 182 slidably supported on the sleeve 179.

The side members of the pulley 176 are formed with inwardly inclined belt-engaging surfaces of the usual type whereby the effective diameter of the pulley is determined by the axial spacing of the members. Adjustments are effected by shifting the member 180, which for that purpose has a cup-shaped member 183 mounted on the collar 182 for rotation relative to the collar but for axial movement therewith. At its open end the collar 182 is threaded internally for cooperation with an externally threaded member 184 rotatably anchored to the sleeve 179 and secured against axial movement thereon. Antifriction bearings 185 and 186 are interposed between the pulley elements and the members 183 and 184 to permit the elements to rotate freely while the members are stationary. As herein shown, the member 183 is held against rotation by a rod 187 extending from that member to the corresponding member of the adjusting means associated with the pulley 177.

Adjustment of the effective diameter of the pulleys 176 is effected by rotation of the adjusting member 184 relative to the associated member 183. Such adjustment of the pulley 176 is effected simultaneously with reverse adjustment of the companion pulley 177 on the generator shaft by means of a chain 189 running over a sprocket wheel 190 rigid with the member 184, a sprocket wheel 191 rigid with the corresponding member on the generator shaft, and a third sprocket wheel 192 (Fig. 8) fast on an adjusting shaft 193 journaled on the frame 172. The shaft 193, as shown, is tubular in form and is mounted on and concentric with an adjusting shaft 194 which has a sprocket 195 cooperating with a chain 189' for adjusting the pulleys forming the driving mechanism for the generator 10. The latter chain runs over sprockets 190' and 191' respectively mounted on the adjusting members of the pulleys on the drive shaft 171' and on the shaft of the generator 10.

Means is provided for adjusting the tension of the chain 189 so as to minimize play or lost motion in the drive adjusting mechanism. The tension adjusting means as herein shown comprises a pair of sprocket wheels 196 and 197 carried by studs secured to an adjusting plate 198. The sprocket wheels are disposed on opposite sides of a chain run and the plate 198 is slotted to permit the sprocket wheels to be shifted transversely of the chain run, thus offsetting a part of the run and taking up any slack therein. The plate 198, in this instance, is supported by the rod 185 extending between the members 183 of the driving and driven pulleys.

Rotation of the adjusting shafts 193 and 194 to regulate the rotative speeds of the generators 9 and 10 is effected through the medium of handwheels 199 and 200 (Figs. 3, 5 and 7) disposed on the side face of the casing 11 for convenient access by the attendant riding the saddle 3. Handwheel 199 is keyed to a shaft 201 connected by gearing 202 with the tubular shaft 193 and handwheel 200 is keyed to a shaft 203 connected by gearing 204 with the shaft 194. Upright shafts 205 having worm gear connections 206 with the shafts 201 and 203 actuate indicators 207 and 208 (Figs. 2, 3 and 8) for providing a visual indication of the setting of the drive mechanisms. As herein shown, these indicators are arranged at the top of the casing 11 so that they may be conveniently observed while the adjustments are made by manipulation of the handwheels 199 and 200.

The motor M, in addition to driving the generators 9 and 10, also supplies power for reciprocating the saddle 3. In the exemplary machine, the saddle is equipped with drive mechanism of the type disclosed and claimed in the Gallimore application Serial No. 547,481, filed July 31, 1944, which issued as Patent No. 2,483,535, dated October 4, 1949. As shown in Figs. 5 and 6, this mechanism includes a pair of pinions 210 and 211 carried by vertically disposed shafts 212 and 213 journaled on the saddle 3 and cooperating with opposed racks 214 and 215 rigid with and extending longitudinally of the machine bed 2. The pinion 210 is driven by a rotary fluid motor 216 through the medium of a transverse shaft 217 having a worm gear 218 coacting with a worm wheel 219 keyed to the shaft 212. The pinion 211 is similarly driven by a rotary fluid motor 220 through a shaft 221, worm 222 and worm gear 223. The fluid motors 216 and 220 are preferably of the reversible, constant displacement type and are flange mounted on the rear wall of the saddle 3 with their operating shafts coupled to the shafts 217 and 221 by speed change gearing G (Fig. 6) actuated by hand levers 221' and 222'.

Pressure fluid is supplied to the motors 216 and 220 by a rotary pump P mounted on the saddle 3 and having its drive shaft 224 coupled directly with the shaft of the motor M. The discharge and return sides of the pump are connected in closed circuit through conduits 225 and 226 in parallel to the intake and exhaust sides of the motors 216 and 220. The pump P has the usual control which is shiftable as by power means through a central or neutral position defining zero displacement into opposite limit positions defining respectively preset displacement of fluids in opposite directions of delivery. Thus when the control member is set in one position, fluid under pressure is delivered through the conduit 225 to the motors 216 and 220 to traverse the saddle 3 in one direction. When the control member is shifted to its alternate position, the supply of pressure fluid is delivered to the conduit 226 and the motors 216 and 220 are reversed to traverse the saddle in the opposite direction.

The pump P is also provided with means for determining its preset displacement, such means being adjustable through the medium of a shaft 227 journaled in brackets 228 on the pump body. Rotation of the shaft 227 is effected by means of a handwheel 229 (Fig. 5) carried on the projecting end of a shaft 230 journaled in the housing 11. A chain 231 running over a sprocket wheel 232 on the shaft 230 and a sprocket wheel 233 on the shaft 227 drivingly connects the shafts. The handwheel 229 is desirably located at one side

of and in line with the generator adjusting handwheels 199 and 200 for convenient access by the machine attendant. Visual indication of the pump setting is provided by an indicator 234 (Figs. 3 and 8) driven from the shaft 230 by worm gearing 235 and an upright shaft 236.

The power means for shifting the reversing controller of the pump P may be of any suitable character and is controlled automatically in response to the reciprocation of the saddle. The present invention provides means for effecting such control of the reversing means which is capable of quick and accurate adjustment to effect the reversal of the pump at any preselected points in the travel of the saddle 3. In the exemplary machine the reversals of the pump are effected by alternate actuation of a pair of control devices, herein shown as switches SW^1 and SW^2 (Fig. 10) in timed relation to the reciprocation of the saddle.

Referring to Fig. 10 of the drawings, the switches SW^1 and SW^2 are disposed in a chamber 240 formed within a casing 241 mounted on the front wall of the housing 11 on the saddle 3. The chamber 240 opens at its lower end into a circular chamber 242 which houses a rotatably supported disk-shaped control member 243 operative to actuate the switches SW^1 and SW^2 as an incident to its rotation. As shown in Figs. 7 and 8 of the drawings, the control member 243 is fixed on the outer end of a horizontally disposed shaft 244 journaled on the frame 172 and provided on its inner end with a worm wheel 245 coacting with a worm 246 on a vertically disposed shaft 247. The latter shaft is journaled in antifriction bearings carried by the frame 172 and the saddle 3 and is provided at its lower end with a pinion 248 meshing with the rack 214 on the machine bed 2. The arrangement is such that the control member 243 is rocked alternately in opposite directions in response to the reciprocation of the saddle 3 and in timed relation thereto.

Mounted on the control member 243 is a pair of switch actuating dogs 250 and 251. The dogs are adjustably secured to the disk so that they may be variably positioned circumferentially thereof, whereby to actuate the switches SW^1 and SW^2 in various selected positions of the saddle. As shown in Fig. 10^a, the control member 243 has in its marginal edge portion an annular T-slot 252 opening in the front face of the member. In the bottom of the slot are a series of pilot holes 253.

The dogs 250 and 251 are generally alike in construction, each having a flat generally wedge-shaped body with an inwardly directed flange 254 adapted to engage the periphery of the member 243 and thus locate the body of the dog over the T-slot 252. The dog is releasably clamped to the member by a clamping bolt having a head portion 255 engaging in the T-slot 252 and a shank portion 256 projecting from the slot through an aperture in the body of the dog. A nut 257 threaded on the projected end of the shank 256 and bearing against the front face of the dog is operable to draw the bolt into clamping relation with the walls of the T-slot and thus securely lock the dog in place on the member 243. When the position of the dog is to be changed, the nut 257 is backed off sufficiently to release the clamping bolt which may then be shifted along the T-slot to the new position.

To facilitate accurate positioning of the dogs 250 and 251 and to assist in maintaining them in set positions on the control member, each of the bolts 256 is formed with an axial bore 258 for the reception of an elongated pilot pin adapted to project at opposite ends beyond the head 252 of the bolt and through a suitable aperture in the nut 257. A spring 260 interposed between the nut 257 and a circumferential flange on the pin yieldably urges the inner end or nose portion of the pin into the pilot hole 253 over which the dog is located. The pilot pin thus cooperates with the pilot hole to locate the dog on the control member 243 and to insure against movement of the dog in case the clamping means is inadvertently released. In adjusting the positions of the dog, the pin is withdrawn from the pilot hole against action of the spring 260 by means of a knob 262 secured on the projecting end of the pin.

To permit a more accurate coordination of the switch operation with the saddle position, the dogs 250 and 251 are arranged to perform their switch actuating functions through the agency of adjustable switch actuators, herein shown as levers 265 and 266 (Fig. 10). Each of the levers is pivotally supported on one end and has its free end positioned to engage the movable member of one of the switches. The levers are arranged in side-by-side relation adjacent one edge of the disk member 243 and are provided with follower rollers 267 and 268 engageable respectively by cam surfaces formed on the dogs 250 and 251, the cam surfaces being offset laterally similarly to the levers.

In order to determine and to regulate the precise point at which either dog is effective to rock its associated lever to switch actuating position, the levers are arranged for adjustment substantially tangentially of the member 243. For this purpose the lever 265 is pivoted on a slide 270 supported in a guideway 271 on the casing 241 at one side of the chamber 240. Shifting of the slide along the guideway is effected by means of an adjusting screw 272 threaded in the slide and rotatably anchored in the side wall of the housing 241. A knob 73 is provided on the projecting end of the screw for manual rotation of the same. The lever 266 is similarly pivoted on a slide 274 supported in a guideway 275 in the housing 241 at the side of the chamber 240 opposite to that at which the slide 270 is located. Adjustment of this slide is effected by a screw 276 having a finger knob 277 on its projecting end.

With the above arrangement a rough adjustment of the points of reversal of the saddle 3 is obtained by locating the dogs 250 and 251 on the member 243 by means of the pilot holes 253 and cooperating pilot pins 259. The pilot holes are preferably spaced apart to correspond to a predetermined range of movement of the saddle, as, for example, a movement of six inches. Accurate determination of the saddle reversing points within this range is obtained by adjustment of the actuating levers 265 and 266 through the medium of the adjusting screws 272 and 276. The adjustments are quickly and easily made and are maintained unchanged while the machine is in operation.

It will be apparent from the foregoing that the invention provides a machine tool of novel and advantageous construction particularly suitable for finishing long surfaces such as the ways on large machine structures. While the machine is especially suited for the performance of grinding operations, its sturdy construction, the rigid support provided for the toolheads and the wide range of adjustability afforded adapts it for the

use of other types of metal removing tools. In general, the machine has an unusually wide range of utility coupled with efficiency and reliability in operation.

The accurate balancing of the toolheads adapts the machine for precision operations usually not considered within the scope of a machine of that size. Such accurate balancing of the toolheads is made possible by equipping them with alternating current motors, and flexibility is attained by providing individual variable speed generators for the motors as an integral part of the machine tool. Efficient and reliable adjusting mechanism is provided for regulating the speed of the generators to meet the requirements of each specific job the machine is called upon to perform.

The invention also provides improved mechanism for manually setting and adjusting the movable machine parts. This mechanism is operable to shift the parts rapidly to reduce idle time to a minimum and yet is capable of positioning the parts with a high degree of precision. Provision is made for automatically controlling the reciprocation of the machine saddle under the control of mechanism characterized by its ease and accuracy of adjustment and by its sturdy foolproof construction.

I claim as my invention:

1. In a way grinder having an elongated work support, a bed disposed at one side of and extending parallel to said work support, a saddle reciprocable on said bed and having an upright column adjacent one end, a rail structure adjustably supported on said column having an arm extending laterally over said work support, a pair of motor driven tool units mounted on said arm, power units mounted on said saddle for supplying power to said tool units, a motor carried by said saddle for driving said power units, and means driven by said motor for reciprocating said saddle.

2. In a way grinder having an elongated work support, a bed disposed at one side of and extending parallel to said work support, a saddle reciprocable on said bed and having an upright column adjacent one end, a rail structure adjustably supported on said column having an arm extending laterally over said work support, a plurality of tool units mounted on said arm, each of said units including an electric driving motor, a plurality of generators mounted on said saddle each operative to supply current to one of said driving motors, and a motor on said saddle having an independent variable speed driving connection with each of said generators.

3. In a way grinder having an elongated work support, a bed disposed at one side of and extending parallel to said work support, a saddle reciprocable on said bed and having an upright column adjacent one end, a rail structure adjustably supported on said column having an arm extending laterally over said work support, a plurality of tool units mounted on said arm, each of said units including an alternating current driving motor, a separate alternating current generator for each driving motor mounted on said saddle, a main driving motor carried by said saddle, and separate driving connections from said main driving motor to said generators, said driving connections being adjustable to vary the speed of said generators and the driving motors supplied with current thereby.

4. In a way grinding machine having a reciprocable saddle with a tool supporting arm mounted thereon, a pair of tool units mounted on said arm, each of said units having a driving motor, a pair of generators supported on said saddle for supplying current to said driving motors, a main driving motor supported on said saddle, independent variable speed driving connections between said main driving motor and said generators each including a drive shaft, adjusting means for each variable speed connection including an endless chain running over one sprocket wheel associated with the generator, a second sprocket wheel associated with the drive shaft, and a third actuating sprocket wheel, and means for rotating said actuating sprocket wheels.

5. In a way grinding machine having a reciprocable saddle with a tool supporting arm mounted thereon, a pair of tool units mounted on said arm, each of said units having a driving motor, a pair of generators supported on said saddle for supplying current to said driving motors, a main driving motor supported on said saddle, independent variable speed driving connections between said main driving motor and said generators each including a drive shaft, adjusting means for the variable speed connections each including an endless chain running over one sprocket wheel associated with the generator, a second sprocket wheel associated with the drive shaft, and a third actuating sprocket wheel, and manually operable means for rotating said actuating sprocket wheels, said manually operable means being mounted for convenient access by an attendant riding on said saddle.

6. In a machine tool of the class described, in combination, an elongated bed, a work support disposed at one side of said bed, a saddle reciprocable longitudinally of said bed, an upright column carried by said saddle, a rail structure adjustably supported on said column having oppositely projecting arms extending substantially beyond the sides of said bed, tool heads including power actuated tool driving means mounted on the respective arms, said column being rotatable about a vertical axis to locate the tool head on either of said arms above said work support, power driven means for reciprocating said saddle to traverse the located tool head longitudinally of said work support, and a power source on said saddle supplying power to the tool driving means on said tool heads and to the saddle reciprocating means.

7. In a grinding machine having roughing and finishing grinding heads, a floor level work support, means supporting said heads for presentation selectively to the work and for traversing the selected head over the work, said supporting means comprising a reciprocable carriage having an upright column thereon, an elongated rail structure mounted on said column for vertical adjustment, said rail structure including oppositely projecting arms dimensioned to extend laterally of said carriage and over said work support, ways on said arms adjustably supporting the respective grinding head, said column being rotatable relative to said carriage to locate either arm of said structure over said work support, and means on said rail structure accessible to an attendant riding said carriage for adjusting said rail structure on said column and said grinding heads on said ways.

8. In a way grinder, in combination, a horizontally reciprocable saddle, an upright column on said saddle, a toolhead carrying structure guided for vertical movement on said column, mechanism for controlling and adjusting the

position of said structure on the column including a shaft rotatably anchored at one end to said structure and extending vertically into said column, said shaft having an enlarged tubular member at its lower end, a threaded nut rigid with the lower end of said tubular member, an upright stud nonrotatably fixed on said saddle and threadedly engaging said nut, said nut coacting with the stud to raise or lower said toolhead carrying structure on said column in response to the rotation of said shaft, a cylinder supported on said saddle and positioned to receive said tubular member with a sliding fit, and means for introducing fluid under pressure into said cylinder below said member to relieve the threads of said nut and said stud of a substantial portion of the weight of said toolhead carrying structure.

9. In a way grinder, in combination, a horizontally reciprocable saddle, an upright column on said saddle, a toolhead carrying structure guided for vertical movement on said column, mechanism for controlling and adjusting the position of said structure on said column including a shaft rotatably anchored at one end to said structure and extending vertically into said column, an upright stud nonrotatably supported on said saddle in axial alinement with said shaft, said stud being threaded for cooperation with a nut carried by and rotatable with said shaft whereby to raise or lower said toolhead supporting structure on said column, a cylinder carried by said saddle positioned to receive the lower end of said shaft, said shaft having an enlargement working as a piston in said cylinder, and means for introducing fluid under pressure into said cylinder below said piston enlargement to counterbalance the weight of said toolhead supporting structure.

10. In a way grinder, in combination, a horizontally reciprocable saddle, an upright column on said saddle, a toolhead carrying structure guided for vertical movement on said column, mechanism for controlling and adjusting the position of said structure on the column including a shaft rotatably anchored at one end to said structure and extending vertically into said column, an upright stud nonrotatably supported on said saddle in axial alinement with said shaft, said stud being threaded for cooperation with a nut carried by and rotatable with said shaft whereby to raise or lower said structure on said column, and pressure fluid actuated means including a piston rigid with said shaft and working in a cylinder carried by said saddle for counterbalancing the weight of said toolhead supporting structure.

11. In a way grinding machine having an elongated bed, a worktable disposed at one side of said bed, a saddle reciprocable on said bed, means on said saddle supporting a motor driven grinding wheel for operating on work supported on said table, a dust hood partially enclosing said grinding wheel, a dust collector operatively connected by a conduit with said hood, means supporting said dust collector for movement in a path substantially parallel to said bed, and means connecting said dust collector to saddle for reciprocation therewith.

12. In a way grinding machine having an elongated bed, a worktable disposed at one side of said bed, a track on the other side of the bed disposed substantially parallel thereto, a saddle reciprocable longitudinally of said bed, means on said saddle supporting a motor driven grinding wheel for operating on work supported on said table, a hood partially enclosing said grinding wheel, a dust collector movable on said track, conduits connecting said dust collector with said dust hood, and means providing a connection between said saddle and said dust collector whereby the latter is reciprocated with said saddle.

13. In a way grinder having an elongated work support, a bed disposed at one side of and extending parallel to said work support, a carriage reciprocable longitudinally of said bed having an upright column adjacent one end, a horizontally disposed rail structure supported on said head and projecting at opposite sides of said carriage, tool units mounted on said rail on opposite sides of said column, said column being rotatable about a vertical axis to locate either tool unit in operative relation to the work support, a motor on said carriage, power transmission means interposed between said motor and said toolheads for driving the toolheads, and controls in said transmission means operable to independently vary the drive for the respective toolheads.

14. In a way grinder having an elongated work support, a bed disposed at one side of and extending parallel to said work support, a carriage reciprocable longitudinally of said bed having an upright column adjacent one end, a horizontally disposed rail structure supported on said head and projecting at opposite sides of said carriage, tool units mounted on said rail on opposite sides of said column, said column being rotatable about a vertical axis to locate either tool unit in operative relation to the work support, and a motor mounted on said carriage supplying power for driving said toolheads and for reciprocating the carriage.

15. In a way grinder having an elongated work support, a bed disposed at one side of and extending generally parallel to the work support, a carriage reciprocable on said bed, a plurality of power driven tool units, means supporting said tool units on said carriage, said supporting means being adjustable to position said tool units individually in operative relation to the work support, power driven means for reciprocating said carriage, power units mounted on said carriage for supplying power to said tool units and said carriage reciprocating means, a motor on said carriage for driving all of said power units, and independently operable control devices associated individually with the respective power units.

16. In a way grinder having an elongated work support, a bed disposed at one side of and extending generally parallel to the work support, a carriage reciprocable on said bed, a plurality of power driven tool units, means supporting said tool units on said carriage, said supporting means being adjustable to position said tool units individually in operative relation to the work support, power driven means for reciprocating said carriage, a series of power supply units on said carriage operatively associated individually with said tool units and said carriage reciprocating means, a common driving motor for said power units, and manually operable control devices for controlling each of said power supply units independently of the other units.

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