Nov. 9, 1971 P. B. CROOP 3,618,265

FINISHING MACHINE FOR METAL SURFACES

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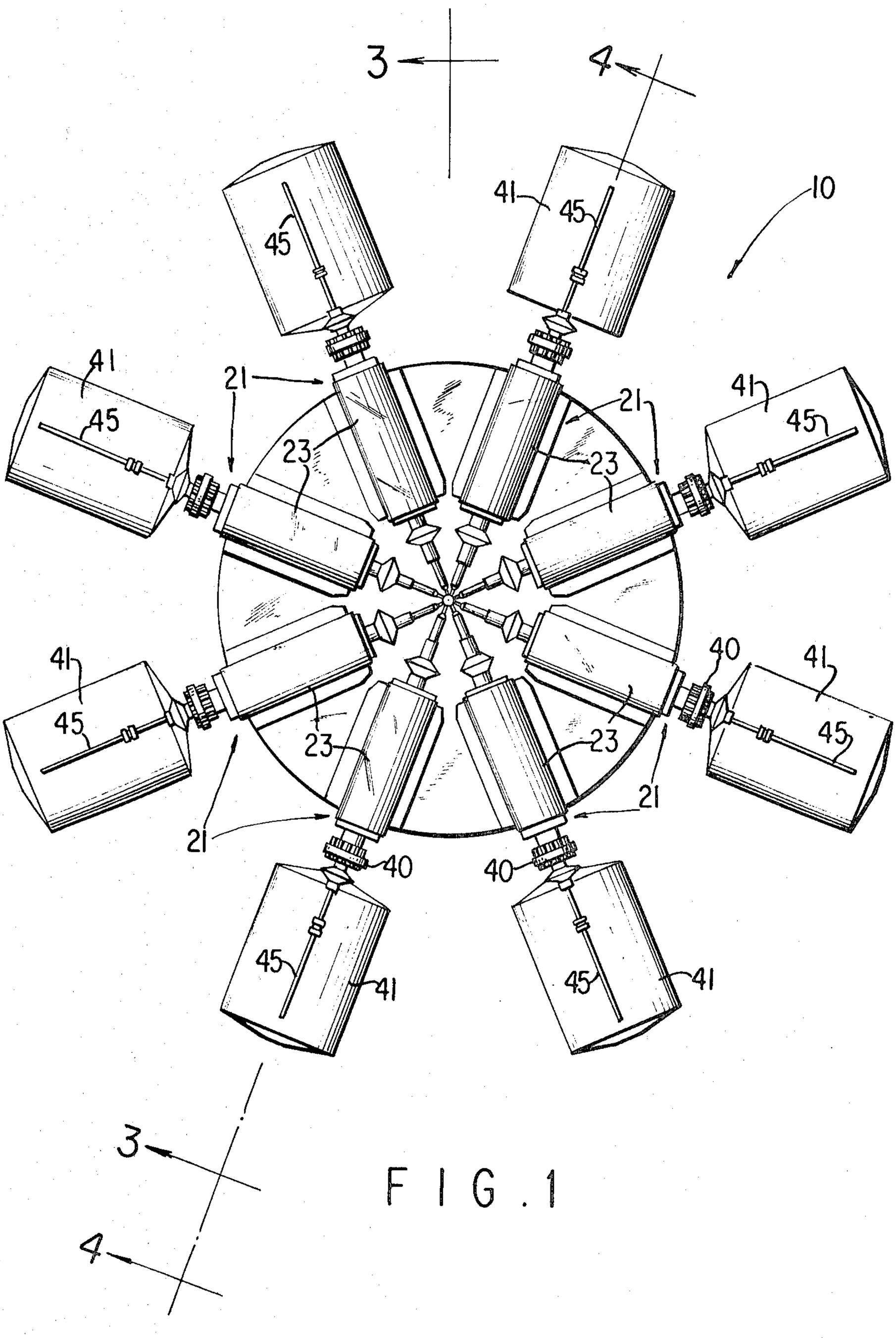

FIG. 1

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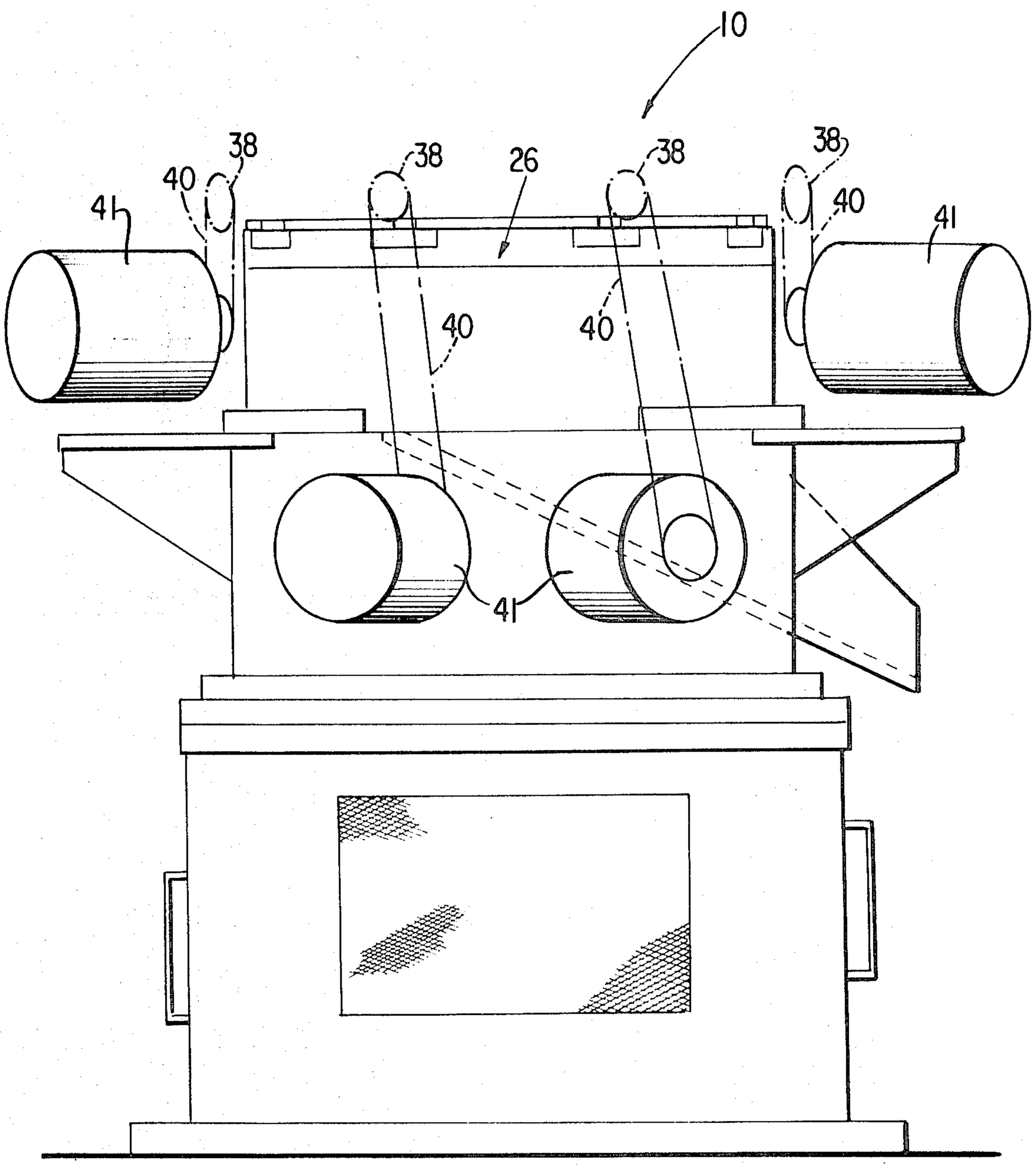

FIG. 2

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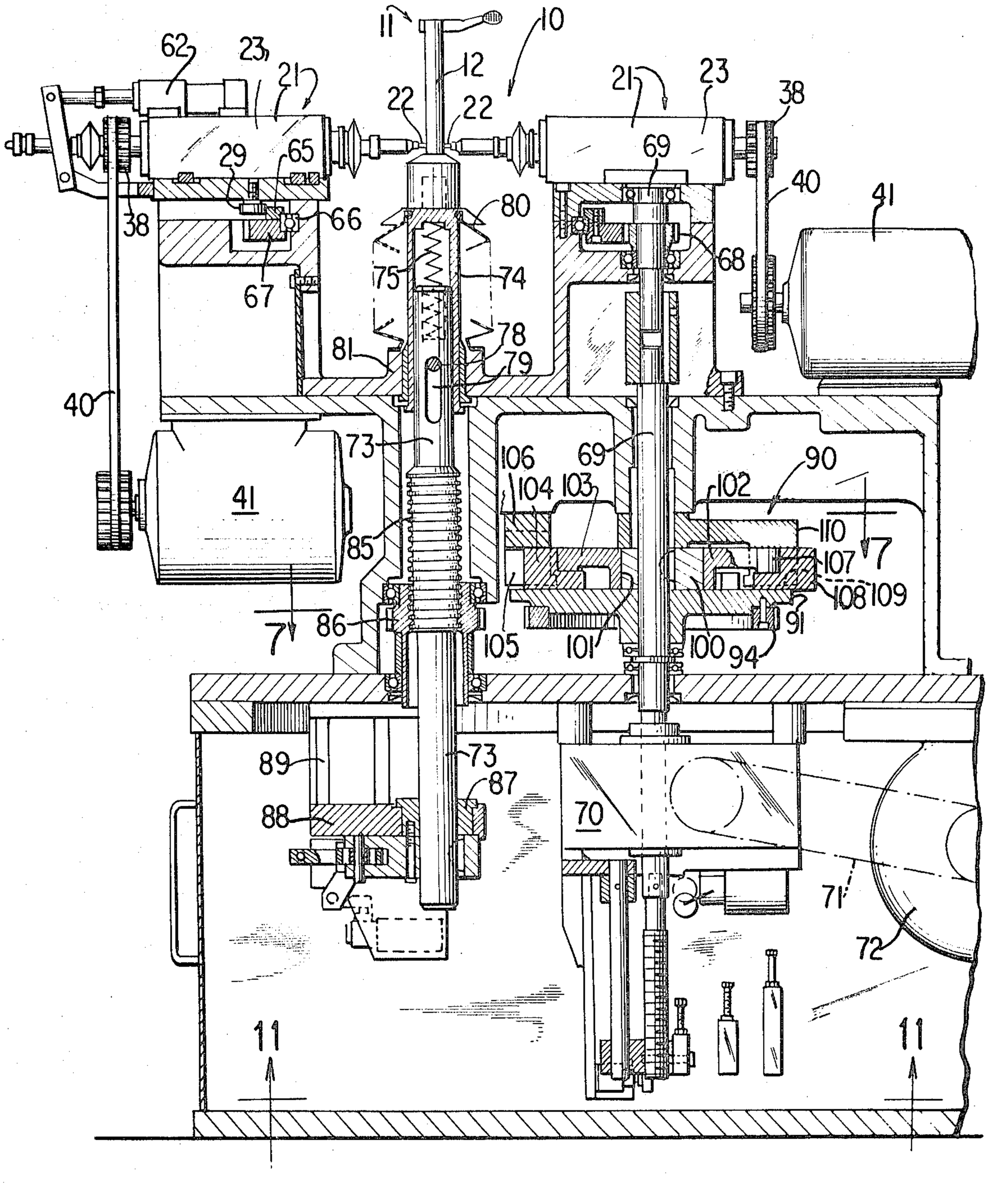

FIG. 3

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FINISHING MACHINE FOR METAL SURFACES

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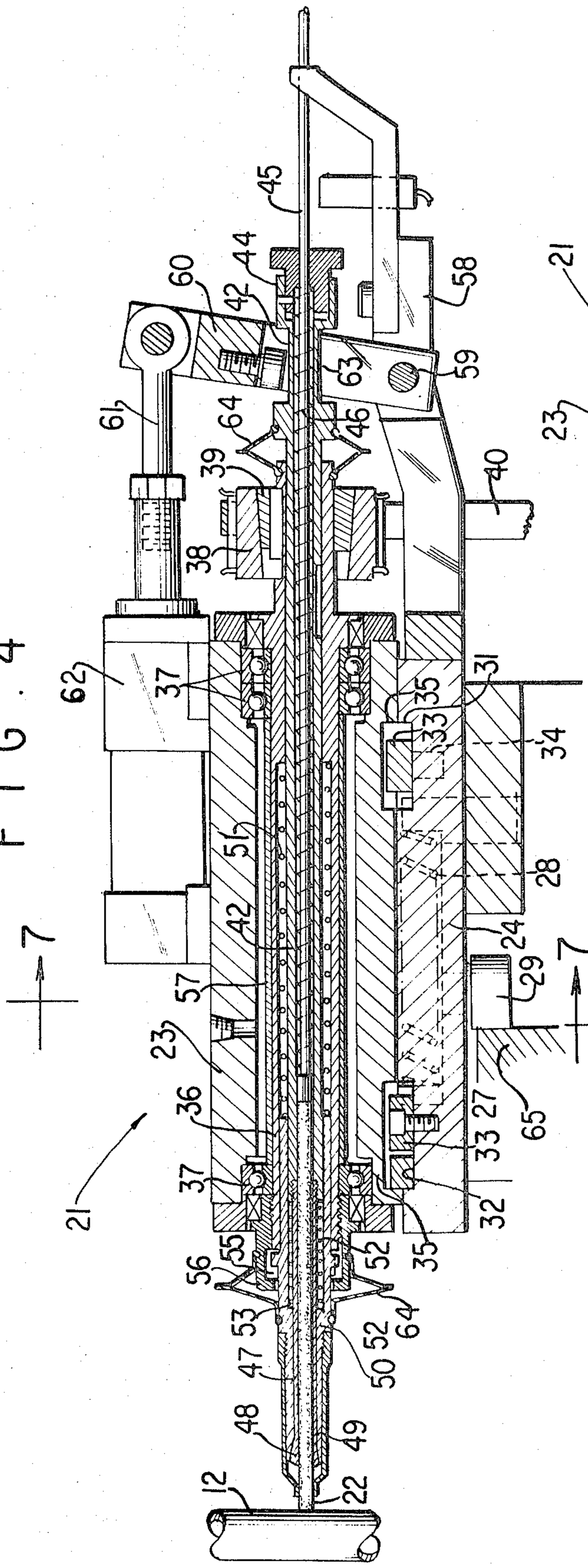

FIG. 4

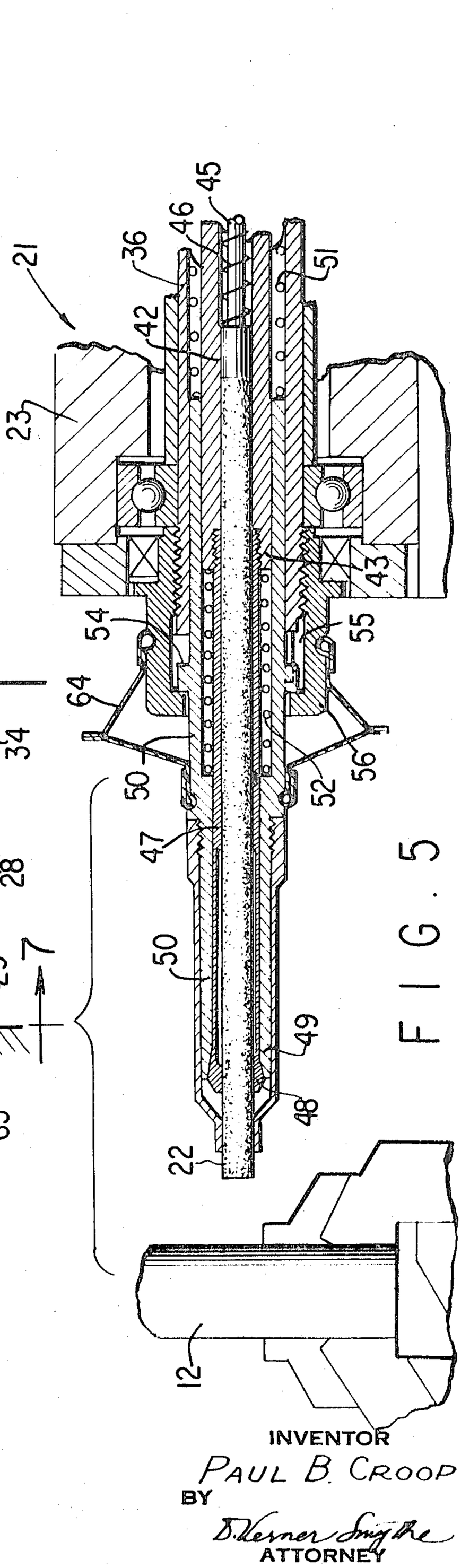

FIG. 5

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FINISHING MACHINE FOR METAL SURFACES

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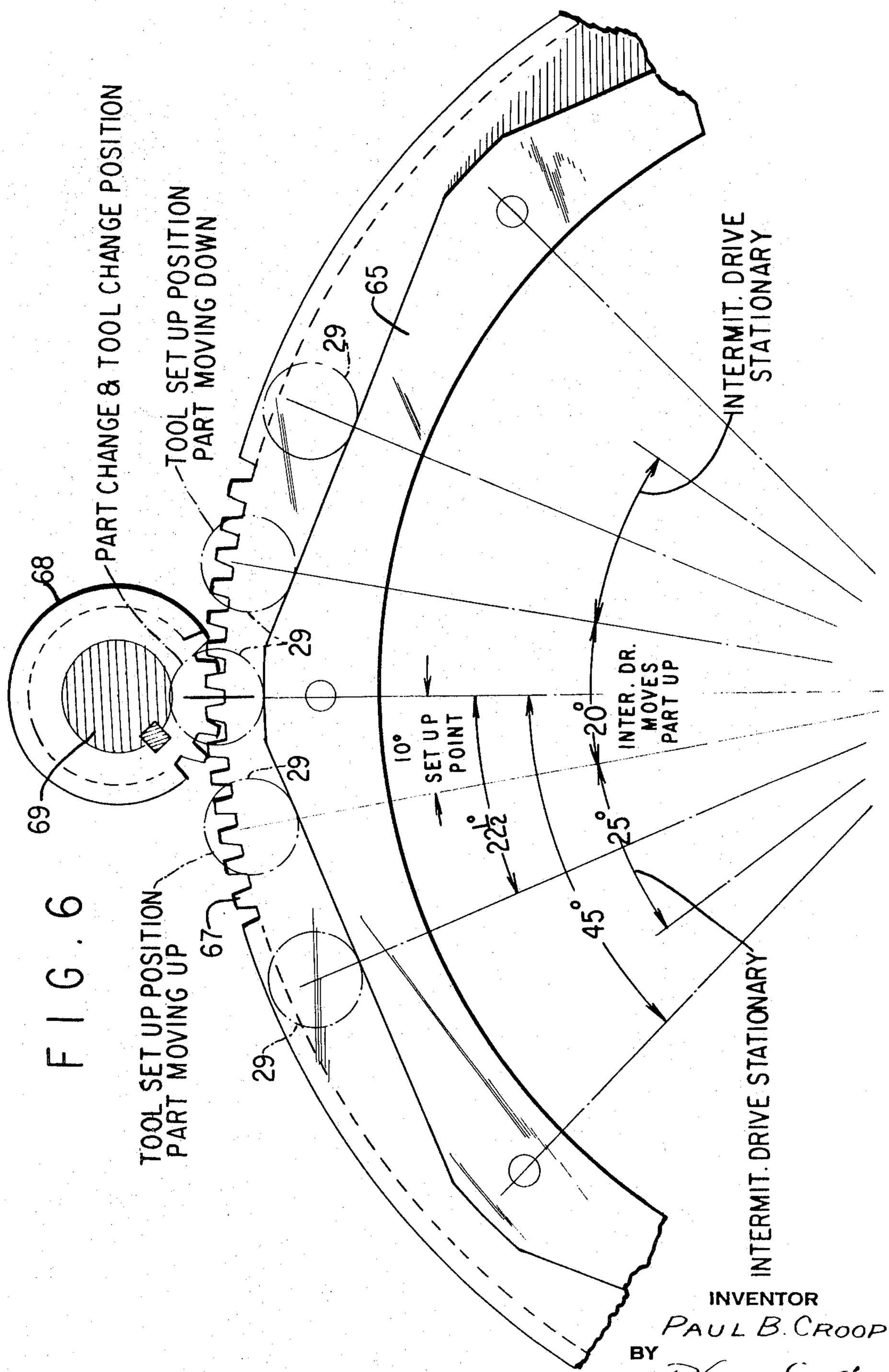

FIG. 6

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FINISHING MACHINE FOR METAL SURFACES

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FIG. 7

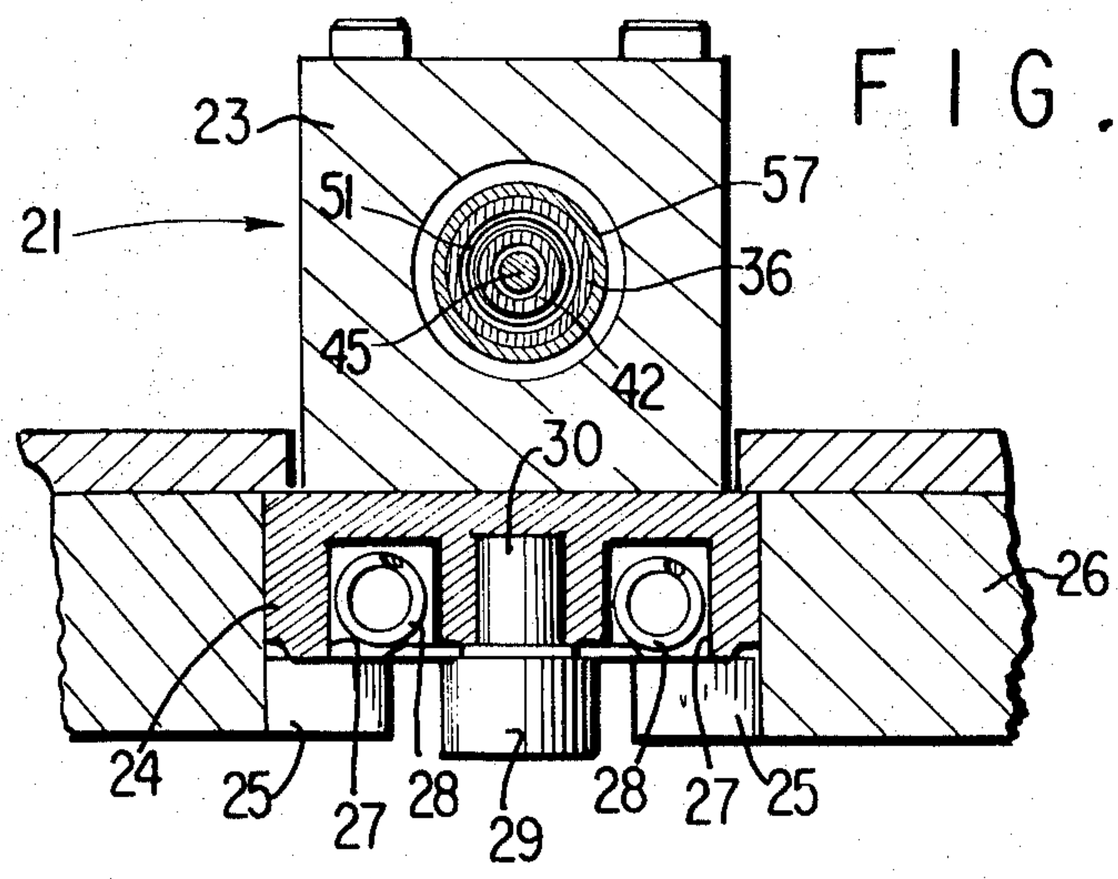
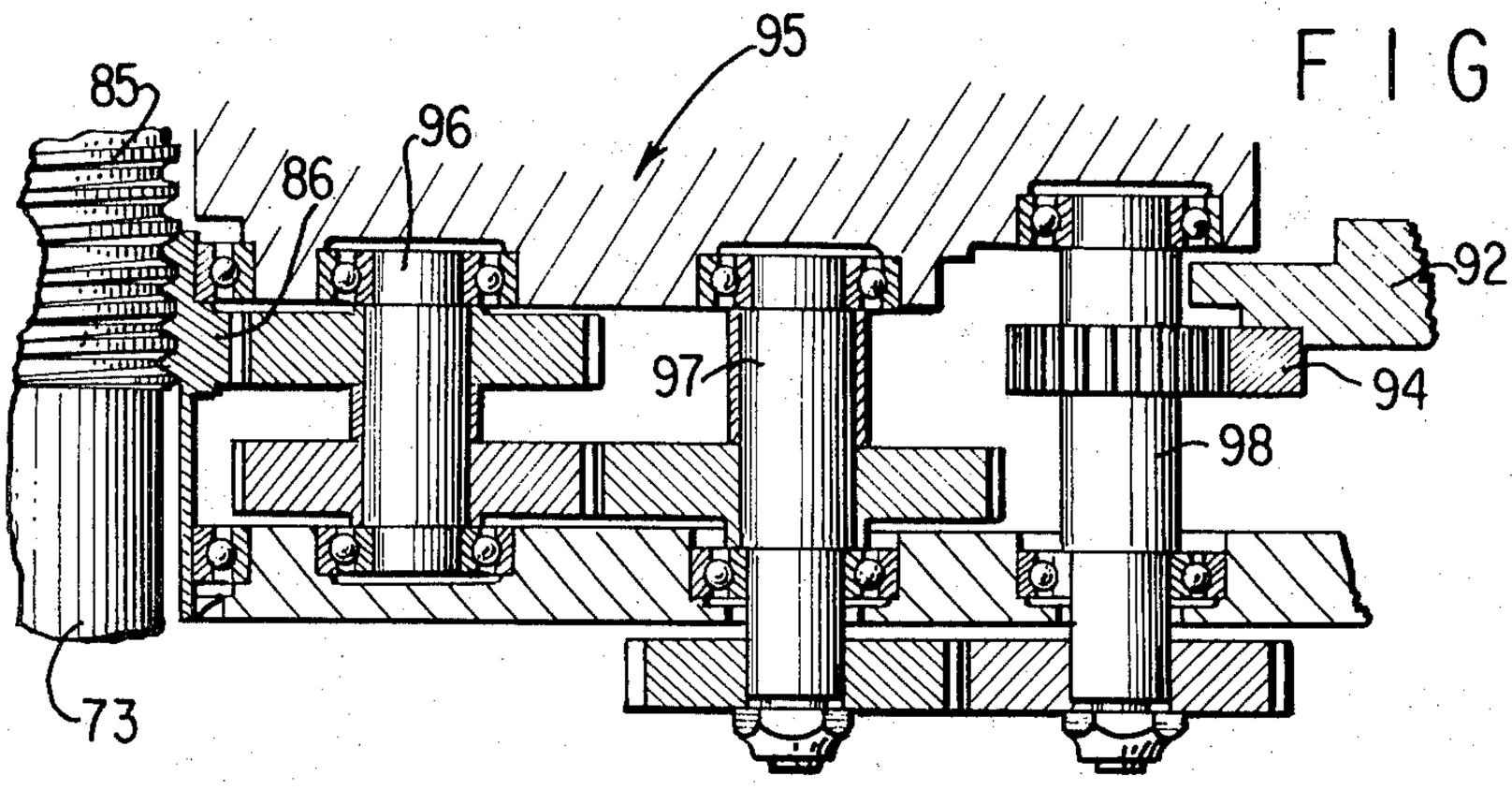


FIG. 10



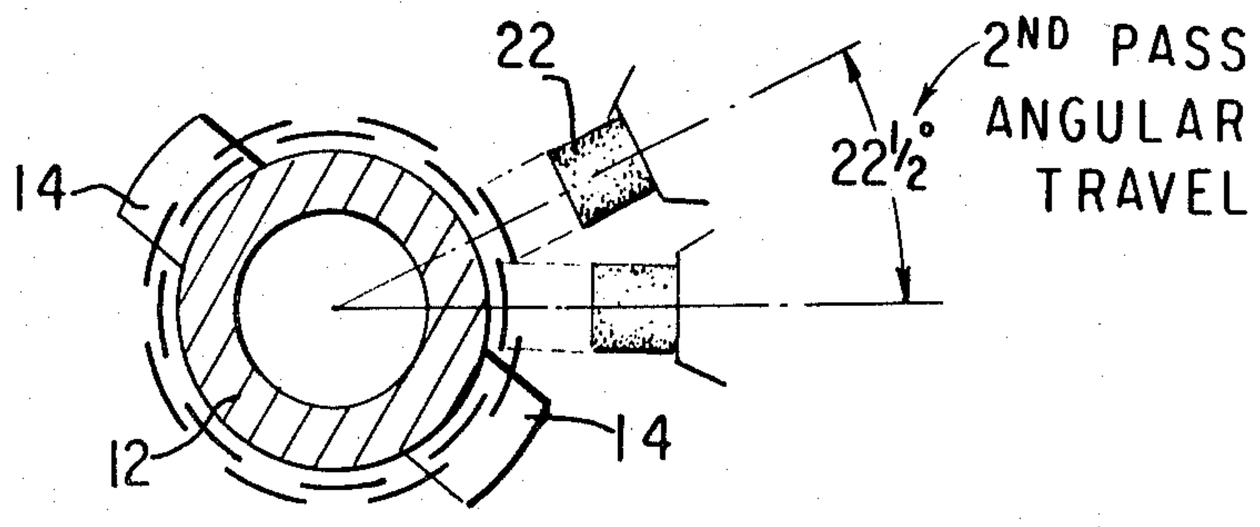


FIG. 15

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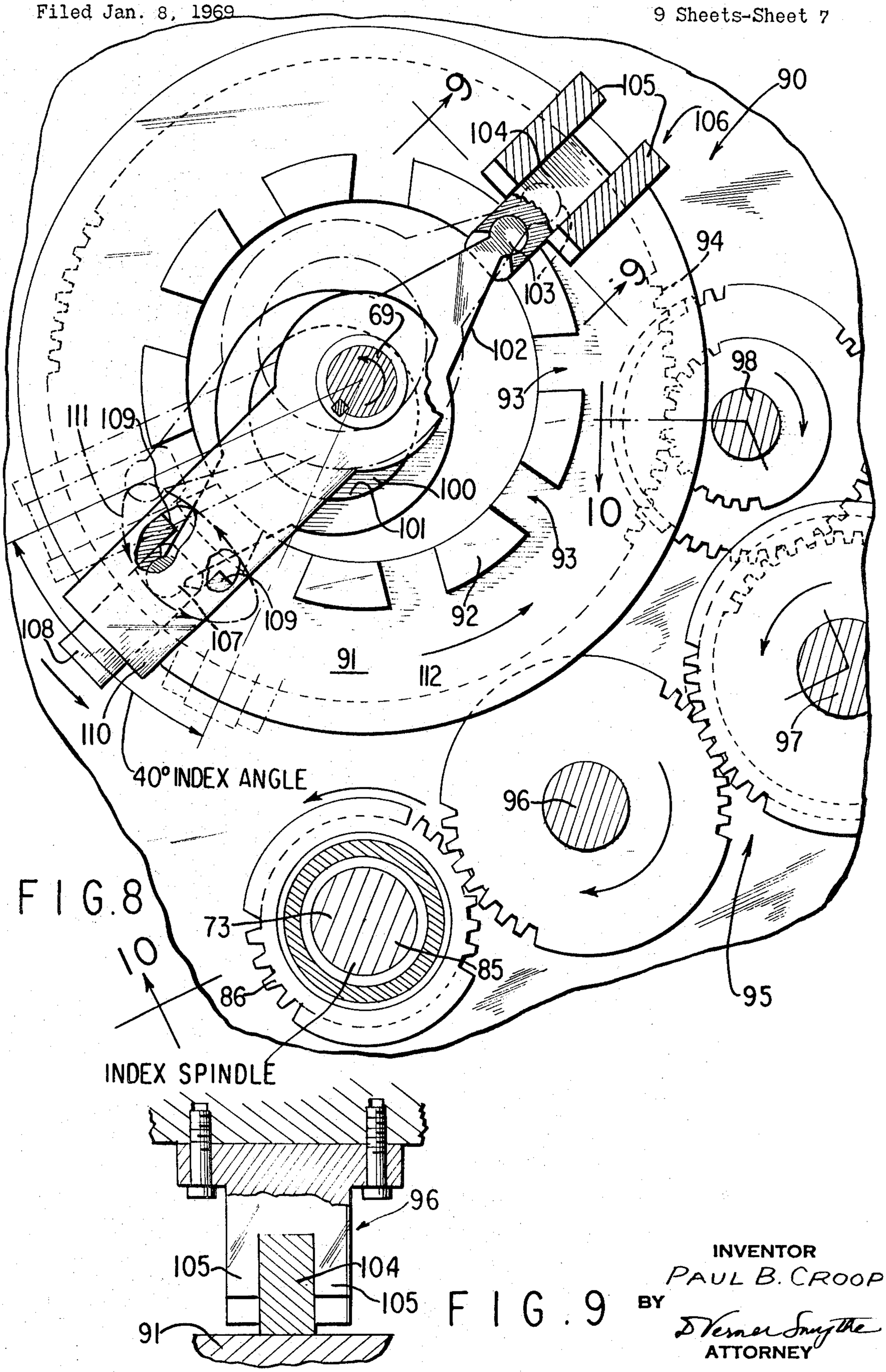

FIG. 8

FIG. 9

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FINISHING MACHINE FOR METAL SURFACES

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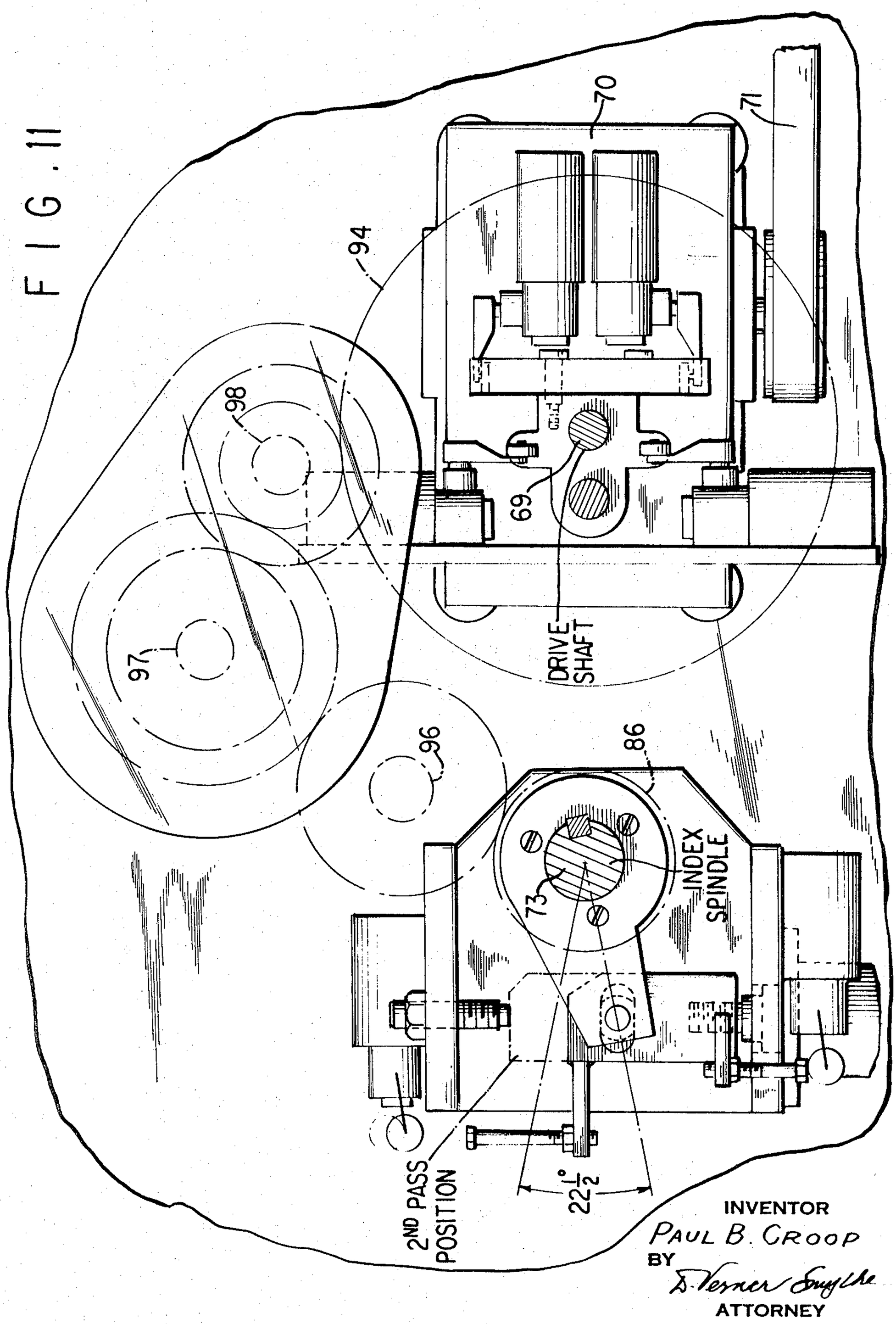
FIG. 11



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FINISHING MACHINE FOR METAL SURFACES

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FIG. 12

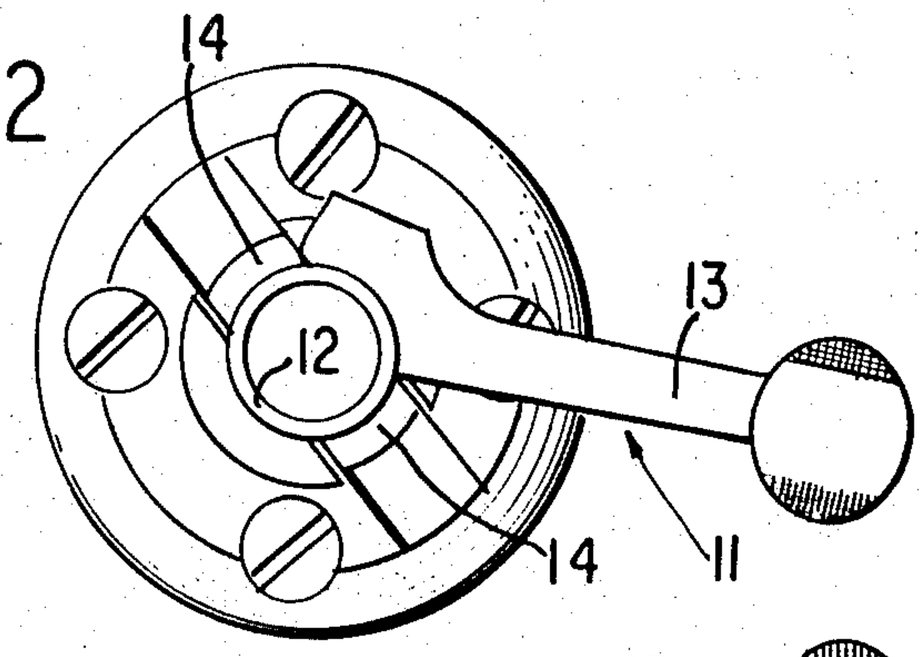


FIG. 13

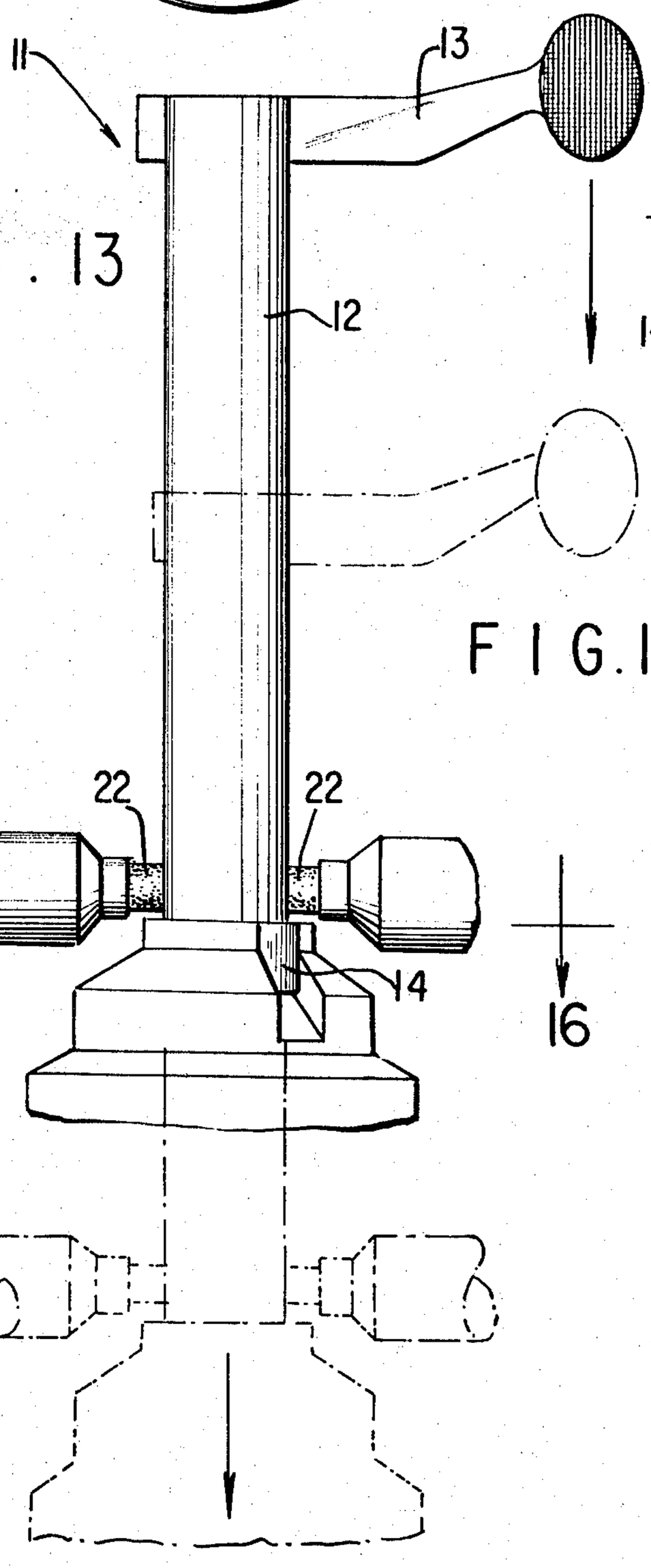


FIG. 14

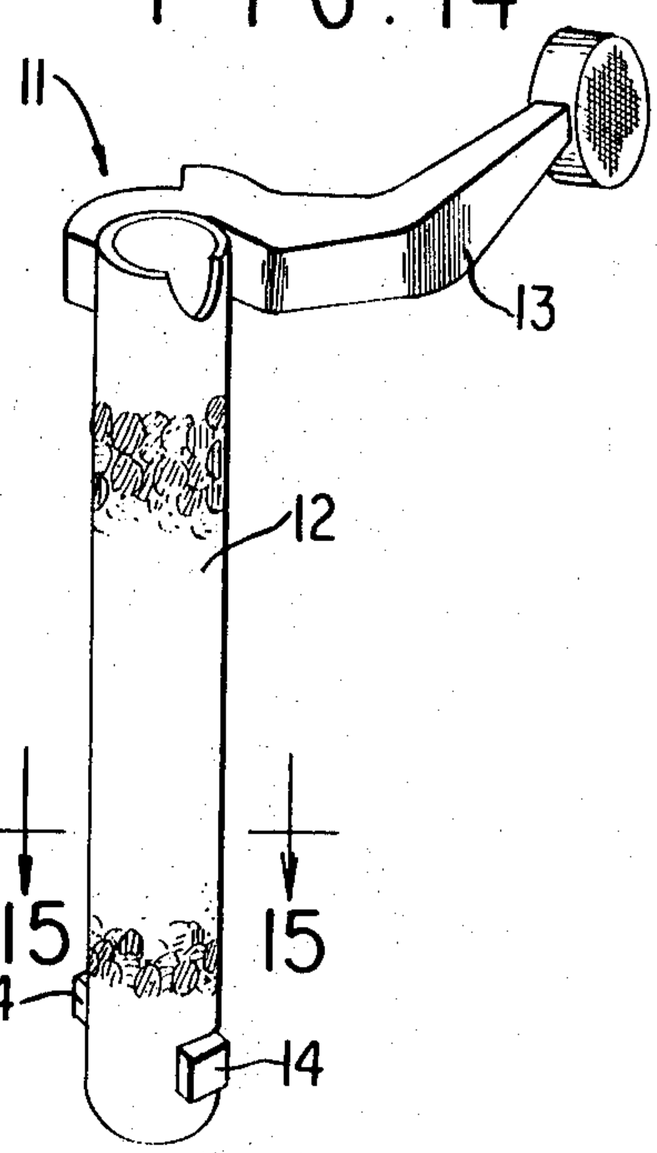
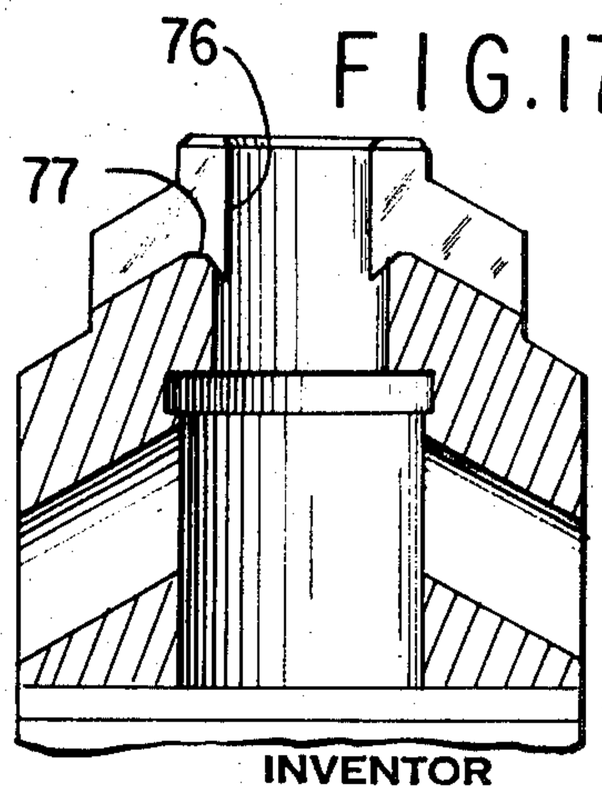


FIG. 16

FIG. 17



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United States Patent Office

3,618,265

Patented Nov. 9, 1971

3,618,265

FINISHING MACHINE FOR METAL SURFACES

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Int. Cl. B24b *5/00*

U.S. Cl. 51—111 15 Claims

ABSTRACT OF THE DISCLOSURE

A machine for finishing the surface of a bolt body or the like wherein the bolt body is indexed axially through a plurality of positions and in each position the surface is subjected to a finishing operation to produce a finish which can be termed a "damaskeen" finish. The finishing operation is carried out by a number of abrasive rods mounted in rotating spindles with the spindles being positioned for reciprocating movement in directions radially or perpendicularly to the bolt body. A rotating drive shaft acts through cam means to reciprocate the spindles according to a predetermined pattern. The drive shaft is also connected through a drive arrangement which intermittently rotates a gear held against axial movement and threadedly engaged with an index spindle so that the index spindle which grips the bolt body is indexed axially in step-wise movements.

The invention relates to metal surface finishing machines to produce a damaskeen pattern surface. A step in the manufacturing of various articles includes imparting a desired finsh to a surface or surfaces of the article. A surface is generally finished by some form of a grinding operation using an abrasive suitable to the surface material and to the finish desired.

In the making of bolt bodies for firearms, it is desired to impart a particular type of finish to a major portion of the body surface. This finish can be generally described as a "damaskeen" finish and comprises a pattern of swirls over the finished surface. An abrasive rod can be brought into contact with portions of the bolt body surface while the rod is being rotated. Formerly, after each finishing operation of a portion of the surface, it was necessary manually to move the bolt body so as to bring another portion of its surface into position with respect to the rotating abrasive rod. It was also necessary to retract the abrasive rod from its grinding position to permit movement of the bolt body to the next position relative thereto. The axial movement or indexing of the bolt body by hand and the manual reciprocating of an abrasive rod to and from its grinding positions consumed a considerable amount of time of a skilled operator. It was also necessary that the operator pay constant attention to the consecutive finishing operations to insure that the finished surface was acceptable. The manual indexing of the bolt body and of the abrasive rod was not satisfactory because of the large amount of time required to finish each bolt body, which correspondingly increased the manufacturing costs, and the non-uniformity of the appearance of finished bolt bodies.

One of the objects of the present invention is to provide a machine for imparting a damaskeen finish to the surface of a work piece.

Another of the objects of the present invention is to provide a machine for finishing the surface of a work piece wherein both the work piece and the abrasive finishing materials are automatically positioned for each finishing operation.

Another of the objects of the invention is to provide a damaskeen machine for bolt bodies wherein the bolt body can be finished without any manual manipulation on the part of an operator.

According to one aspect of the present invention, a machine for finishing the surface of a work piece may comprise a holder to retain the work piece for axial movement. A plurality of spindles are mounted on the machine for reciprocating movement and extend perpendicularly to the surface of the work piece being finished. Where the work piece surface is cylindrical, the spindles extend radially from the work piece and are spaced equidistantly about its circumference. There are means for moving the spindles inwardly toward the work piece surface into a finishing operation position and then retracting the spindles outwardly upon completion of the finishing operation. Means are provided for indexing the work piece axially upon completion of a finishing operation and at the end of a traverse, to angularly index the work piece.

Other objects, advantages and features of the present invention will be apparent from the accompanying description and drawings, which are merely exemplary.

In the drawings:

FIG. 1 is a top plan view of the machine according to the present invention with a portion of the bolt body holder removed;

FIG. 2 is a side elevational view of the machine of FIG. 1;

FIG. 3 is a sectional view taken along the line **3—3** of FIG. 1;

FIG. 4 is a sectional view of the spindle and taken along the line **4—4** of FIG. 1;

FIG. 5 is a portion of the view of FIG. 4 and shows the spindle in the retracted position and the abrasive rod being released from the clamping collet;

FIG. 6 is a plan view of the cam for reciprocating the spindles;

FIG. 7 is a sectional view taken along the line **7—7** of FIG. 4;

FIG. 8 is a sectional view taken along the line **8—8** of FIG. 3 and showing the intermittent drive arrangement for the index spindle;

FIG. 9 is a sectional view taken along the line **9—9** of FIG. 8;

FIG. 10 is a roll-out sectional view taken along the line **10—10** of FIG. 8;

FIG. 11 is a sectional view taken along the line **11—11** of FIG. 3 and looking upwardly at the index spindle and drive shaft;

FIG. 12 is a top plan view of the bolt body holder and showing the bolt body in position therein;

FIG. 13 is a side elevational view of the bolt body holder and the top of the index spindle and showing the bolt body in indexed positions;

FIG. 14 is an overall perspective view of the bolt body whose surface is finished with the machine of the present invention;

FIG. 15 is a sectional view taken along the line **15—15** of FIG. 14;

FIG. 16 is a sectional view taken along the line **16—16** of FIG. 13; and

FIG. 17 is a longitudinal sectional view of the upper end of the index spindle and showing the structure therein for gripping the lower end of the bolt body.

Proceeding next to the drawing wherein like reference symbols indicate the same parts throughout the various views, a specific embodiment of the present invention will be described in detail.

The machine for imparting a damaskeen finish to a bolt body according to the present invention is indicated generally at **10** in FIGS. 1–3. A bolt which is to be finished is indicated at **11** in FIG. 14 and comprises a bolt body **12** and a handle **13**. At the lower end of the bolt body there are provided locking lugs **14**.

The bolt **11** is retained in a work piece holder indicated generally at **15**. The bolt is inserted into socket **15**. In its initial position, the lower end of the bolt bearing lugs **14** extends from the bottom of the fixture to be gripped by the socket of the index spindle in a manner to be presently described.

As may be seen in FIG. 1, a plurality of spindles **21** are positioned radially about the bolt on the top of the machine **10**. The spindles are illustrated in greater detail in FIGS. 3–5 and each carries an abrasive rod **22**. Each spindle is capable of reciprocating motion in a direction radially of the bolt body **12**. Rod **22** is preferably a rubberized abrasive, sold under the name "Cratex," a trademark of Cratex Manufacturing Co.

Spindle **21** comprises a spindle housing **23** mounted upon base **24**. Base **24** is slidably mounted upon guides **25** supported within the top surface **26** of the machine frame. The undersurface of base **24** is provided with two longitudinally extending grooves **27** which receive springs **28**. A cam roller **29** is rotatably mounted on shaft **30** in the underside of base **24**.

The upper surface of base **24** is provided with longitudinally extending slots **31, 32** within which are positioned cushion members **33** mounted on screws **34**. These cushion members **33** extend upwardly into corresponding grooves **35** formed in the underside of spindle housing **23**. It can be seen that cooperating grooves **31** and **35** are slightly longer than cushion members **33** to permit some play between the spindle housing and the base.

In spindle housing **23**, a tubular casing **36** is journalled at both ends by bearings **37** with both ends of the casing extending outwardly of the housing **23**. The rear end of casing **36** has a pulley **38** keyed thereon by key **39** with the pulley being drivingly connected by drive belt **40** to an electric motor **41**.

Slidably mounted within tubular casing **36** for axial movement therein is a first tubular member **42** having a forward end **43** and a rear end **44**. The rear end **44** projects outwardly of the casing **36** as may be seen in FIG. 4. The inner diameter of tubular member **43** is such to closely receive the abrasive rod **22** with the rod being capable of axial movement therein. A plunger **45** is urged by a spring **46** against the end of the rod.

From forward end **43** of the tubular member **42**, there extends outwardly a thin walled extension **47** having a plurality of longitudinal slots therein and a circumferential enlargement **48** at the outer end to define a collet to grip the rod **22**. The collet **48** is engageable by the flaring end **49** of a second tubular member **50** which is slidably mounted around the forward end of tubular member **42** and biased outwardly by a spring **51**. A second spring **52** is positioned between an inner shoulder **53** on tubular member **50** and an external shoulder formed on the end **43** of tubular member **42**.

The movement of tubular member **50** within casing **36** is limited by an annular shoulder **54** movable in an annular space **55** formed at the outer end of tubular casing **36** by a nipple **56**.

The anti-friction bearings **37** at the ends of tubular casing **36** are maintained at a predetermined distance by a cylindrical bushing **57**.

Extending rearwardly from base **24** is a bracket **58** to which is pivotally connected at **59** an arm **60** connected at its other end to a piston rod **61** of a hydraulic cylinder **62**. The arm **60** is split so as to straddle a groove **63** formed in the rear end **44** of tubular member **42**. It will be apparent that actuation of hydraulic cylinder **62** will cause the arm **60** to pivot and thereby reciprocate tubular member **42** within the spindle.

When the spindle is in the retracted position (FIG. 5) and the hydraulic cylinder **62** is actuated, tubular member **42** will be moved forwardly and collet **48** will be disengaged from the flaring end **49** of tubular member **50** whereby the resilient structure of collet **48** will release

rod **22** for axial movement under the force exerted by plunger **45** and spring **46**.

The ends of tubular element which move in respect to each other may be enclosed by flexible bellows covers **64** as shown in FIGS. 4 and 5.

The reciprocating movement of the spindles **21** which causes each spindle to advance and to retract with respect to the bolt body is controlled by the cam roller **29** and a circular cam **65** journalled in the machine by bearings **66** as may be seen in FIG. 3. Attached to the underside of circular cam **65** is a ring gear **67** engaged by a pinion gear **68** keyed to the upper end of a drive shaft **69**. Drive shaft **69** is journalled in a vertical position in the machine as may be seen in FIG. 3 and is driven through a reduction drive **70** through a drive belt **71** and an electric motor **72**.

The circular cam **65** and its associated ring gear **67** is shown in greater detail in FIG. 6. The cam comprises a plurality of cam surfaces corresponding to the plurality of spindles. In the present embodiment there are provided eight spindles which are equi-distantly spaced about the periphery of the bolt body. It is to be understood, however, that the number of spindles may vary and need not be restricted to the number of spindles employed in the present embodiment.

An index spindle **73** is rotatably mounted within the machine for limited axial movement. On the upper end of index spindle **73** there is provided a tubular extension **74** which is resiliently held in the position shown in FIG. 3 by an internal spring **75**. The upper end of extension **74** is shown in greater detail in FIG. 17 and has an opening **76** with internal lips **77** for receiving the lugs **14** on the bolt **11**. The lips **77** serve to grip the lower end of the bolt and to move the bolt axially through its fixture **18**. Extension **76** is slidably mounted on the end of index spindle **73** with the range of axial movement being limited by a pin **78** passing through an axial slot **79** in the index spindle.

A flexible boot **80** may connect the outer end of tubular extension **73** with a boss portion **81** of the machine through which the index spindle passes.

A threaded section **85** is provided along the central portion of the index spindle and meshes with a gear **86** which is restrained against axial movement. It will be apparent that rotation of gear **86** will cause the threaded portion **85**, and thus index spindle **73**, to move axially through the gear.

The lower end of index spindle **73** is journalled in a bearing **87** carried in a bracket **88** attached to the machine frame at **89**.

The axial movement of index spindle **73** indexes axially the bolt body within the fixture **18**. The intermittent rotation of gear **86** and therefore the intermittent axial movement of index spindle **73** is accomplished through an intermittent drive mechanism indicated generally at **90** in FIG. 3 and driven by the rotating drive shaft **69**.

The intermittent drive mechanism, as illustrated in FIGS. 3 and 8, comprises an indexing disk **91** having a plurality of spaced blocks **92** on its upper surface to define indexing slots or notches **93**. A ring gear **94** is attached to the underside of indexing disk **91** and meshes through a gear train indicated generally at **95** with gear **86** engaging the index spindle. The gear train **95** comprises shafts **96, 97**, and **98** which are journalled in the machine and have meshing spur gears thereon as shown in FIG. 10.

An eccentric **100** is keyed to the drive shaft **69** and rotates within an opening **101** in an indexing arm **102**. At one end of the indexing arm there is provided a pin **103** which is journalled in a block **104** with the block being slidable between the legs **105** of a stationary bracket **106** attached to the machine.

The other end of indexing arm **102** is similarly provided with a pin **107** which is journalled within a block **108**

slidable between the legs **109** of a pivoting arm **110** which pivots about drive shaft **69**.

Inner end of block **108** is tapered, as may be seen in FIG. 8, so that this block may slide into the indexing notches **93**. The pin **107** will describe the somewhat elliptical path **111**, as shown in FIG. 8, as the drive shaft **69** rotates. It will be apparent that the block **108** will be moved into a notch **93** and, while engaged with this notch, will move the indexing disk in the direction of the arrow **112**. When the indexing disk moves through a 40° index angle, the block will be retracted from the indexing notch to be disengaged therefrom and moved rearwardly to engage the next succeeding notch. With each movement of the indexing disk, the gear train will be correspondingly moved to intermittently rotate gear **86**. The rotation of gear **86**, while being held against axial movement, will impart an axial movement to the index spindle **73**.

In response to the described operation of the intermittent drive, the index spindle **69** will be moved downwardly until twenty-three finishing operations have been carried out by the spindles on the bolt body surface. This represents the limit of the downward axial movement of the index spindle. At this point the drive motor **72** is stopped and the fixture is indexed automatically through an angle of 22½°. This movement positions the bolt body at a new angle of 22½° so as to subject other surface portions to the action of the abrasive rods in a manner as shown in FIG. 15. The main drive motor is then reversed and energized so as to rotate the drive shaft in the opposite direction. This reversed rotation of the drive shaft will be transmitted through the intermittent drive assembly to index the index spindle in an axial movement upwardly. Again, the bolt body part will be indexed twenty-three times and at each dwell will be subjected to a finishing operation.

When the predetermined number of operations have been carried out, the machine is stopped, the bolt is removed from the fixture and the machine is ready for recycling.

Thus, it can be seen that the bolt body is provided with a decorated surface produced by the action of an abrasive point, not unlike a draftsman's electric eraser, on the metal surface. Each application of the abrasive point produces a concentric swirl on the surface. A multiplicity of such applications are made in an overlapping uniformly geometrically spaced arrangement so as to provide a highly decorative effect.

The machine of the present invention supports a cylindrical bolt body in a vertical position. In uniformly radially spaced relationship about the longitudinal axis of the bolt body are eight automatically advanced and retracted rotating spindles each tipped with a suitable abrasive tool. At each advance of the eight spindles, eight spots or swirls are formed on the surface of the bolt body. The bolt body then successively indexes or feeds downwardly to each of twenty-three different vertically spaced stations at each of which eight more spots or swirls are formed on the bolt body surface. At the bottom of the stroke, the bolt body is rotated 22½° about its axis and the process repeated with the bolt body being indexed upwardly and with eight more sets of overlapping swirls being formed at each of the twenty-three vertically spaced positions.

The surface of other than a round bolt, e.g., a relatively flat surface, can be finished by arranging the machine spindle as needed. The movement of a spindle should be approximately perpendicular or normal to the surface being finished.

It will be understood that various details of construction and arrangement of parts may be made without departing from the spirit of the invention except as defined in the appended claims.

What is claimed is:

1. In a machine for finishing the surface of a work piece, a holder to retain the work piece for axial movement thereof, a plurality of spindles extending perpendicularly to the surface of the work piece being finished, means for moving said spindles inwardly toward said work piece surface in a finishing operation and moving said spindles outwardly upon completion of the finishing operation, and means for indexing said work piece stepwise axially in one direction upon completion of a finishing operation, said spindles being moved inwardly in said finishing operation while said work piece is at rest during the stepwise rest period of said work piece until the length of the work piece surface has been subjected to finishing operations, and means to pivot said work piece about its longitudinal axis through a predetermined angle and then to index it axially in the opposite direction, so as to produce an overlapping pattern of spaced decorative spots on the work piece.

2. In a machine as claimed in claim **1** with said work piece surface being cylindrical, said spindles extending radially to said work piece surface.

3. In a machine as claimed in claim **1** and a rod of abrasive material mounted in each of said spindles with an end of said rod projecting from the spindle and to be moved into contact with the work piece surface.

4. In a machine as claimed in claim **3** and means on said spindles for advancing step-wise the abrasive rod ends outwardly after each completion of a finishing operation.

5. In a machine as claimed in claim **1** and comprising a drive shaft rotatably mounted in said machine and operatively connected to a power source, said spindle moving means and said indexing means being operated in response to the rotation of said drive shaft.

6. In a machine as claimed in claim **1** with said indexing means comprising an index spindle mounted for rotational and axial movement in said machine, and means on an end of said index spindle for gripping said work piece to move axially the work piece therewith.

7. In a machine as claimed in claim **6** and comprising a drive shaft rotatably mounted in said machine and operatively connected to a power source, and means operatively connecting said drive shaft and index spindle for moving said index spindle intermittently in an axial direction in response to the rotation of said drive shaft.

8. In a machine as claimed in claim **7** with said index spindle moving means comprising a threaded portion on said index spindle, a gear having internal threads meshing with said index spindle threaded portion and gear teeth about the periphery thereof, said gear being retained against axial movement, and means engaging said gear teeth for intermittently rotating said gear in response to the rotation of said drive shaft.

9. In a machine as claimed in claim **5** with there being a plurality of bases slidably mounted on the machine and each spindle being mounted on a base, said spindle moving means comprising cam means responsive to the rotation of said drive shaft for reciprocating said spindles.

10. In a machine as claimed in claim **9** with said cam means comprising a circular cam rotatably mounted in said machine and having a plurality of cam surfaces corresponding to the plurality of spindles, gear means for driving said circular cam from said drive shaft, and a cam follower on each spindle engaging said cam surfaces for reciprocating said spindle in a predetermined sequence.

11. In a machine as claimed in claim **3** with said spindles each comprising an elongated tubular member for retaining the abrasive material rod, spring means for urging said rod outwardly toward the work piece surface, releasable means for gripping said rod in the retained position, and means for releasing said gripping means upon completion of a finishing operation so that said rod can be urged outwardly by said spring means.

12. In a machine as claimed in claim 9 with each spindle comprising a housing mounted on said base, and a rotatable element journalled in said housing.

13. In a machine as claimed in claim 12 and comprising means on said machine for rotating said spindle rotatable elements.

14. In a machine as claimed in claim 12 with said spindle rotating element comprising a tubular casing journalled within said spindle housing, a first tubular member slidably mounted within said tubular casing for axial movement therein and for receiving a rod of abrasive material, both ends of said first tubular member projecting outwardly of said tubular housing, resilient means on the end of said first tubular member adjacent the work piece for clamping the rod of abrasive material in position, a second tubular member surrounding said first tubular member and spring biased to hold said resilient clamping means in clamping position against the abrasive rod, and means on said spindle housing for moving said first tubular member axially to disengage said resilient clamp means whereby said rod is free for axial movement.

15. In a machine as claimed in claim 14 with said first tubular member moving means operatively connected to the other end of said first tubular member.

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U.S. Cl. X.R.

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