Aug. 18, 1970 R. S. JONES 3,524,283

GRINDING MACHINERY

Filed Jan. 9, 1967 3 Sheets-Sheet 1

Fig. 1

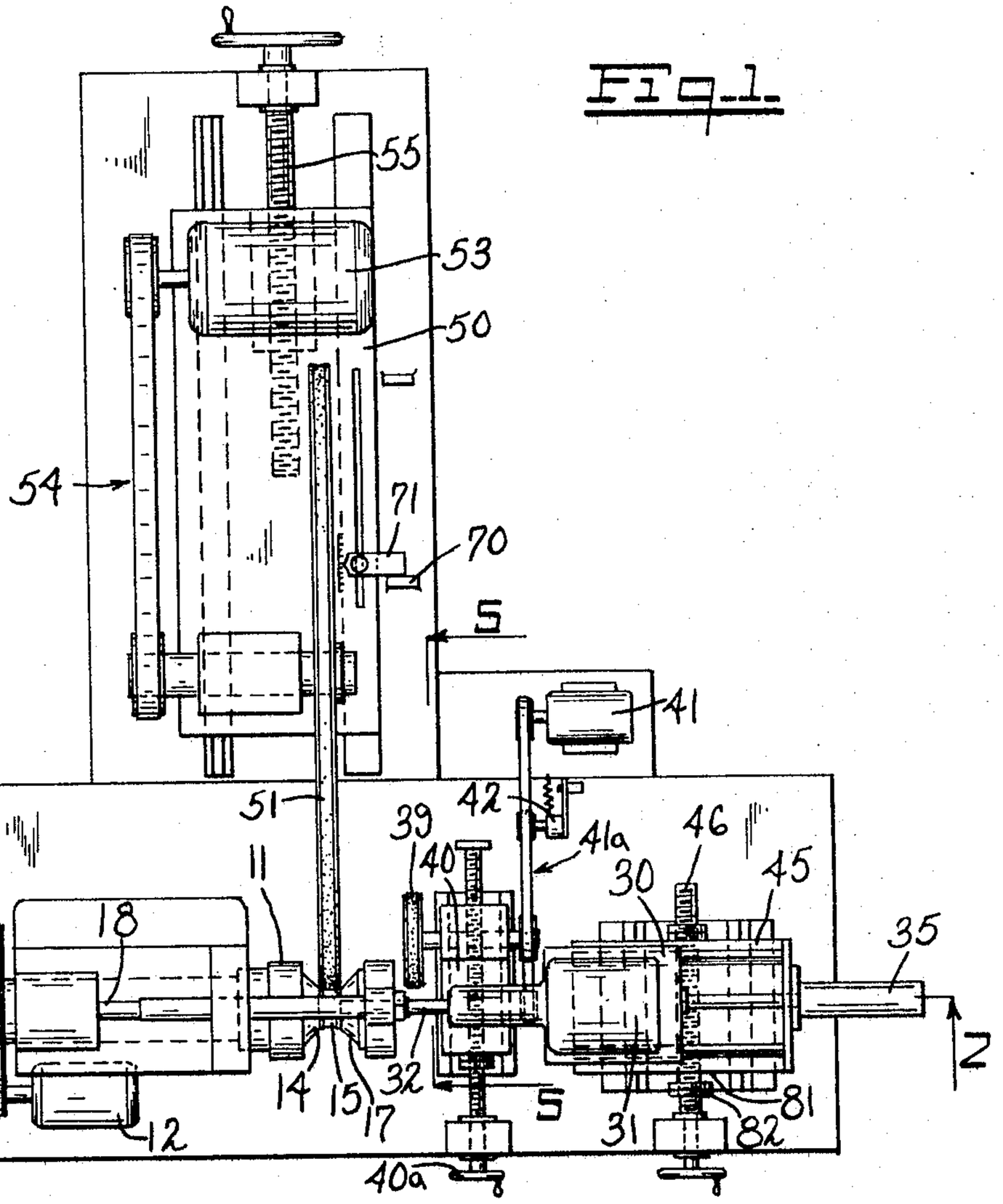
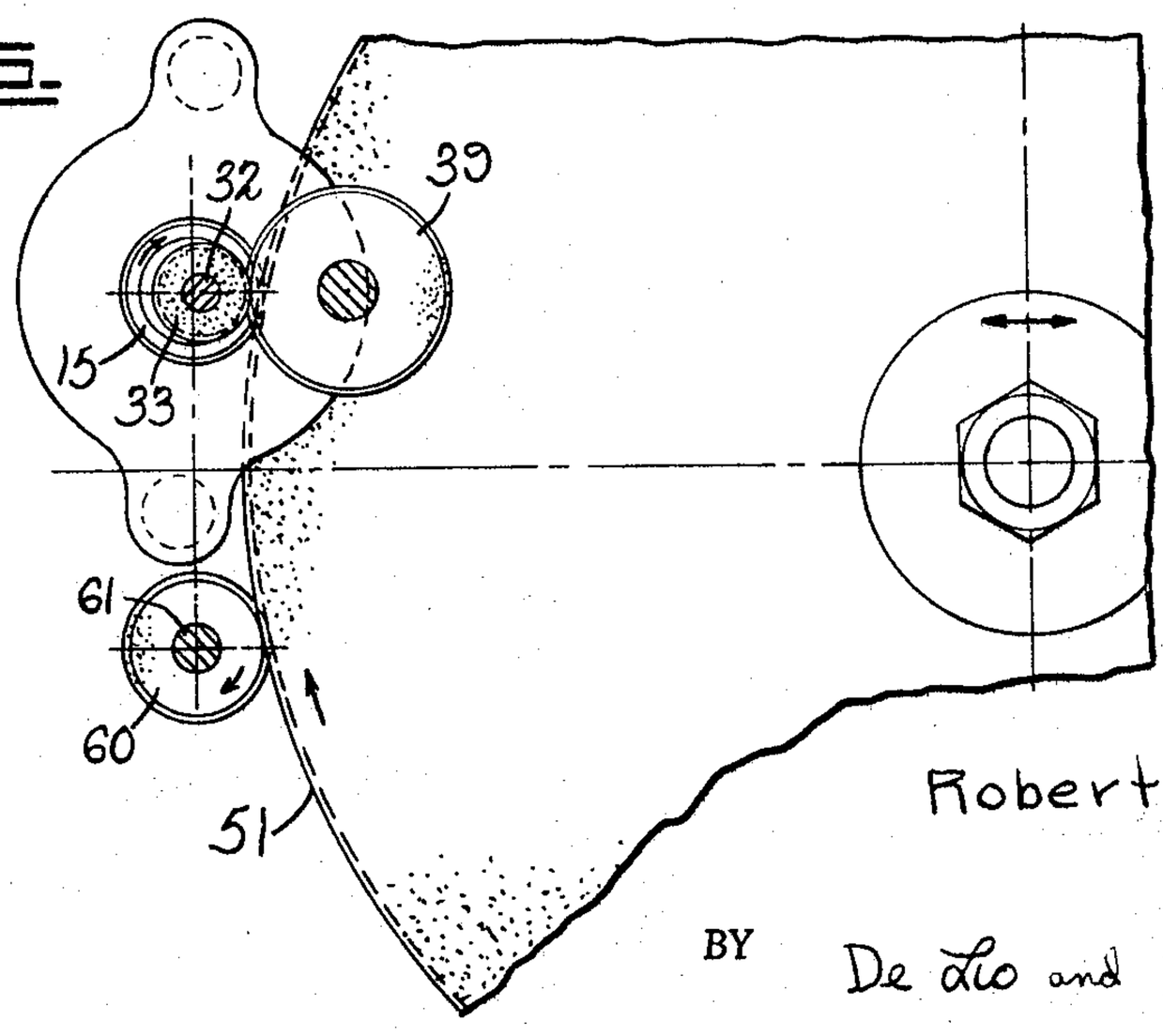


Fig. 5



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Filed Jan. 9, 1967 3 Sheets-Sheet 2

FIG. 1.

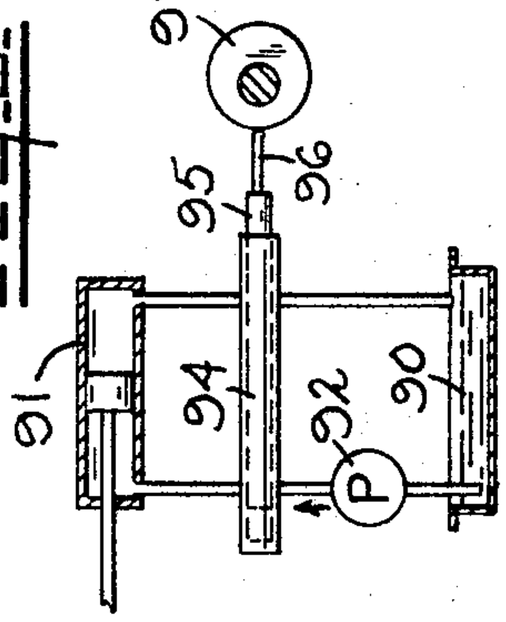

FIG. 2.

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Filed Jan. 9, 1967 3 Sheets-Sheet 3

Fig. 3.

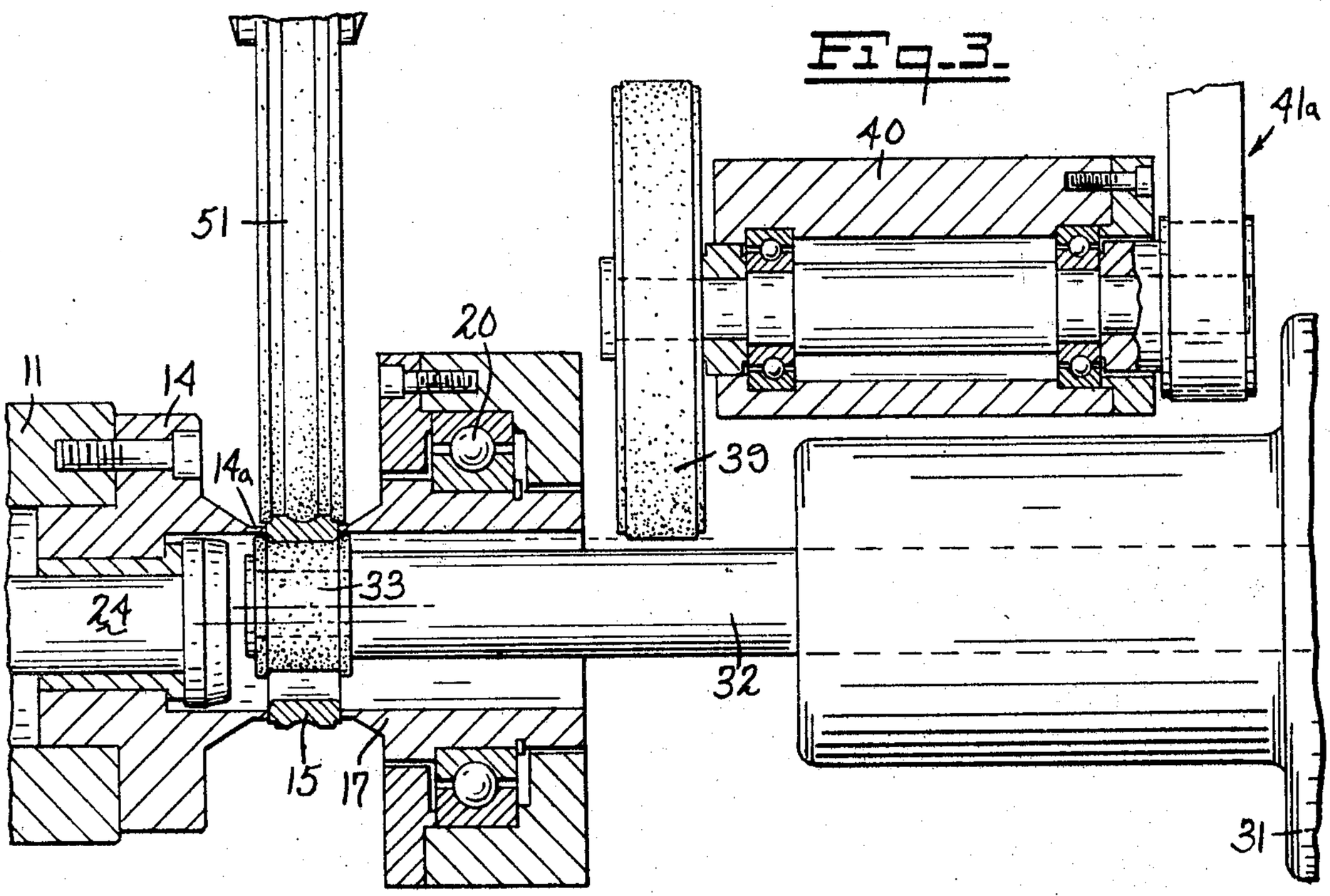
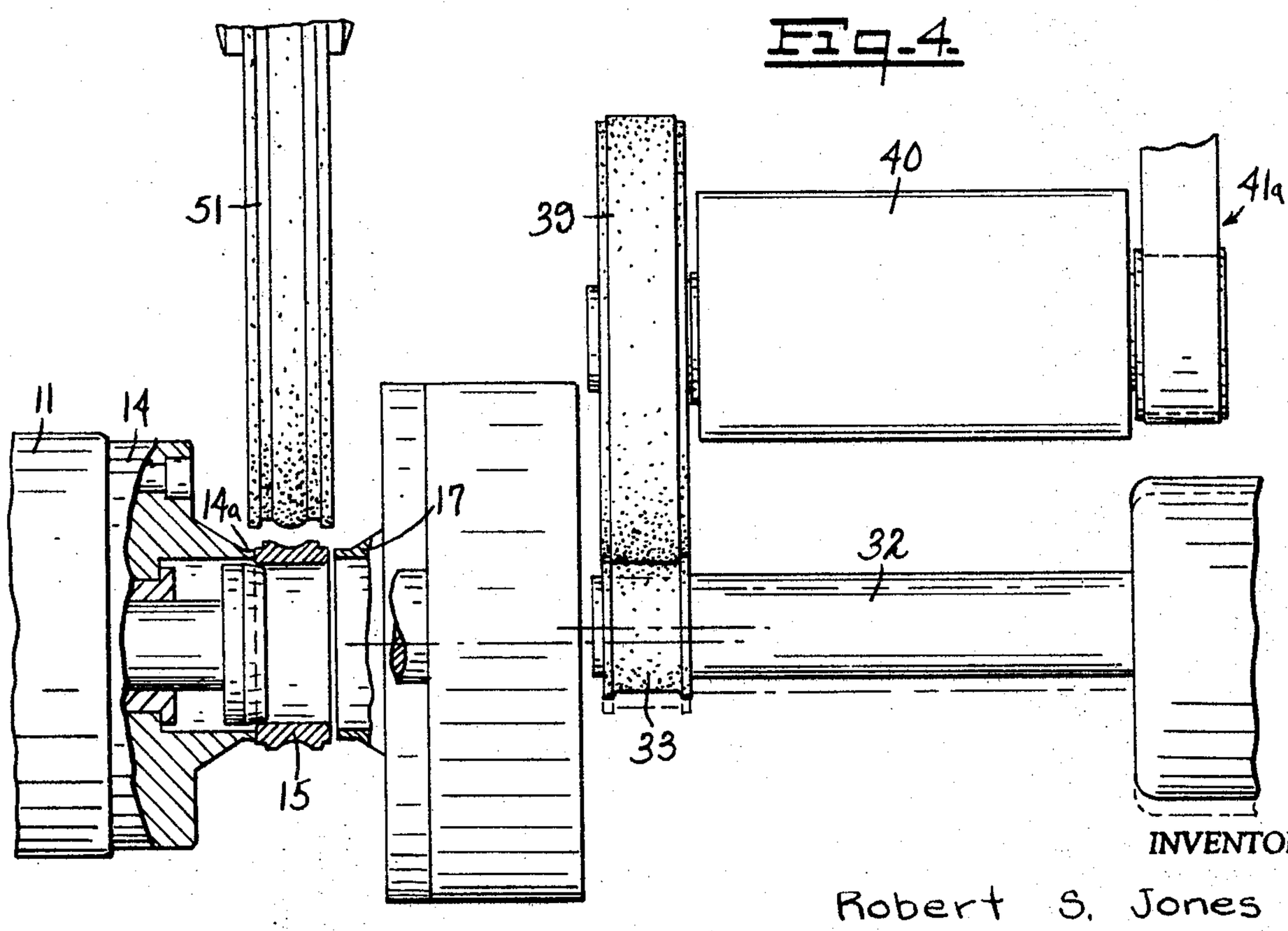


Fig. 4.



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GRINDING MACHINERY

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Int. Cl. B24b 5/12, 53/04
U.S. Cl. 51—5 5 Claims

ABSTRACT OF THE DISCLOSURE

A grinding machine for grinding the external and internal surfaces of a workpiece, comprising a grinding wheel which is rotated about its axis and moved to simultaneously contact a first cutter wheel rotating about its axis and a workpiece rotating about its axis, such that the axis of the workpiece and the axis of the cutter wheel lie in substantially the same vertical plane and are spaced less than 180° from each other about the circumference of the first grinding wheel. The apparatus may also include a second grinding wheel which is adapted to be rotated and moved to operate on the internal surface of the workpiece or to contact a second cutter wheel.

This invention relates to grinding machinery for grinding surfaces of substantially cylindrical or substantially cylindrical hollow workpieces.

This invention is particularly useful for simultaneously form grinding the inside diameter and the outside diameter of either inner race rings or outer race rings of ball bearings. However, this invention is not confined to grinding ball bearing rings since the disclosure herein is equally applicable to the grinding of cylindrical surfaces or rings for any purpose.

This invention also provides for truing or dressing the inside or outside diameter grinding means by cutter means positioned such that compensation need not be provided to take into account the material removed from the grinding means during truing.

In the past, the geometric relationship of the grinding wheel, the dressing means and the workpiece was such that extreme accuracy in truing feed movement was necessary to produce the correct work size. In prior art grinding and dressing machines in which dressing takes place on the opposite side of the grinding wheel from that used in grinding, it is also necessary to compensate for the material removed from the grinder by the dresser as well as to compensate for the thermal changes encountered in the operation of the machinery. These disadvantages of the prior art not only resulted in manufacturing quality control problems, but also increased the costs in operating such machines because of waste and set-up time required.

In view of the foregoing, applicant has provided a new and improved grinding machine, which provides significant advantages over the prior art. Particularly, the geometric relationship of the grinder, the dresser and the work are such that means for compensating for the material removed from the grinder during truing is no longer required. Additionally, the accuracy of the work is insured by utilizing the dresser or cutter to control the size of the workpiece being ground.

Accordingly, it is an object of this invention to provide a new and improved grinding machine.

A further object of this invention is to provide a grinding machine in which the grinding wheel, a rotating dresser and the work are positioned in geometric relationship, such that the position of the dresser sets the work size.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification.

The invention accordingly comprises the apparatus embodying features of construction, combination of elements and arrangement of parts, all as exemplified in the following detailed disclosure and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference is had to the following detailed description, taken in connection with the accompanying drawings, in which:

FIG. 1 is a top view of a grinding machine according to this invention;

FIG. 2 is a sectional view taken along line **2—2** of FIG. 1;

FIG. 3 is a sectional view taken along line **3—3** of FIG. 2;

FIG. 4 is a view similar to FIG. 3, showing the position of the parts of the machine in a different relationship than that shown in FIG. 3;

FIG. 5 is a schematic view taken along line **5—5** of FIG. 1; and

FIG. 6 is an example shown schematically of means for controlling the hydraulic system according to the invention.

Referring now to FIGS. 1–5, there is shown according to the invention a frame **10** on which is mounted a headstock **11** driven by a motor **12** through a belt and pulley system generally shown at **13**. A rotating spindle portion **14** of the headstock **11** supports a workpiece shown at **15**, such as a ring for a ball bearing. A hydraulically-actuated pressure plate is shown at **17**. The pressure pressure plate is controlled by pistons shown at **18** and **19**. The plate **17** is mounted on anti-friction bearings shown at **20** and is adapted by the action of pistons **18** and **19** to force the workpiece **15** against the spindle nose **14**. There is also provided a hydraulic cylinder **23** for moving a tapered plunger **24** carried within the headstock spindle **14** for locating the work concentrically on the driving ring of the spindle prior to clamping by the pressure plate **17**. The head of the plunger **24** enters the interior of the inner diameter portion of the workpiece and centers it, such that the pressure plate **17** may be used to clamp the workpiece against the spindle ring shown at **14***a*.

The workpiece **15** may be supplied to the grinding machine by an indexing plate which carries the workpieces from a feed chute to a position adjacent to the headstock driving ring and after they have been ground carries the finished rings to the discharge chute. The type of indexing plate which may be used is of the Geneva type which has been used in the past on machine tools and/or grinding machines. It will be understood that the workpiece may be inserted by hand, if desired.

There is shown at **30** a slide which carries a motor **31** for driving a spindle **32** carrying an inside diameter grinding wheel **33**. The slide **30** is moved axially by the provision of a hydraulic cylinder **35** having a piston **36**. By the action of the piston **36** the grinding wheel **33** may be moved axially with respect to the workpiece in order to position it for grinding the inside diameter of the workpiece **15**. For positioning the grinding wheel **33** in the proper axial position relative to a rotating cutter or dressing wheel **39**, the slide **30** is moved in the opposite direction. The dressing wheel **39** is also supported in a slide **40** and is movable by a hand crank **40***a* so that it may move inwardly or outwardly from the internal diameter grinding wheel **33**. The dressing wheel **39** is driven by a motor **41** through a belt and pulley arrangement **41***a*. The belt is held taut by the provision of a spring loaded mechanism shown at **42**.

As may also be seen, the slide **30** is mounted on a second slidable member **45** which may be positioned by a

hand cranked screw **46**, such that the grinding wheel **33** may be moved radially with respect to the workpiece **15** or radially with respect to the dressing wheel **39**.

As may also been seen in FIGS. 1 and 2, a slide **50** is provided for supporting an external grinding wheel **51** which is driven by a motor **53** through a belt and pulley arrangement shown at **54**. The slide **50** is arranged to be fed radially with respect to the work to provide infeed for grinding the outside diameter of the workpiece **15**. This is accomplished by the provision of a screw **55** which may be rotated manually.

As may be clearly seen in FIGS. 1 and 2, there is provided a truing wheel **60** mounted on a spindle **61** and driven through the belt and pulley arrangement **41***a* by the motor **41**. The wheel **60** is preferably of diamond material and is mounted on a slide **65** which is also moved by an adjustable screw **66**, such that it may be moved radially toward or away from the grinding wheel **51**.

As may be more particularly seen in FIG. 5, the workpiece **15** and the dressing wheel **60** are positioned with respect to the circumference of the grinding wheel **51**, such that they are both on the same side of grinding wheel **51**. The axis of the supporting spindle for the workpiece, as well as the axis for the dressing wheel, lie preferably in the same vertical plane and are separated by an arc of less than 180° and preferably less than an arc of 45°, along the outside circumference of grinding wheel **51**.

In the preferred embodiment, the center of the work-holding spindle is preferably placed approximately two inches above the horizontal axis of the external grinding wheel **51**, whereas the center of the rotating diamond cutter **60**, used for truing the external wheel **51**, is placed an equal distance below the horizontal axis of the external grinding wheel **51**. The axes of the work spindle and the rotating diamond cutter spindle preferably lie in the same vertical plane and parallel to the axes of the grinding wheels **51** and **33**. This particular geometric arrangement of components provides some unique advantages. It brings the outside diameter of the rotating diamond cutter **60** and the outside diameter of the finished workpiece in contact with the periphery of the external grinding wheel at the same time, regardless of the size of the grinding wheel **51**. Thus the size of the outside diameter of the finished workpiece is controlled by the position of the rotating diamond cutter provided the outside diameter of the grinding wheel is advanced until it contacts the outside diameter of the cutter.

The preferred method for utilizing the outside diameter grinding wheel **51** is as follows. The external slide **50** and the wheel **51** are advanced to a fixed stop position. The fixed stop is provided by a stop shown at **70** which engages an adjustable stop member **71** supported on the slide **50**. A series of workpieces are then ground, the exact number having been determined by experience to be a practical number of parts to grind before redressing the wheel. After the predetermined number of pieces has been ground, the stop member **71** is adjusted to allow the slide **50** to advance approximately an extra .001 inch on the next infeed cycle. Near the end of this next infeed cycle, when the first workpiece encountered has been ground to size, the outside diameter grinding wheel will contact the outside diameter of the rotating diamond cutter **60** and about .001 inch of grinding grit and bond will be removed from the outside diameter of the grinding wheel, thereby exposing a new layer of freshly dressed grinding crystals. No more material will be removed from the workpiece during the final .001 infeed of the wheel **51**. The machine will again be operated a predetermined number of grinding cycles and the wheel slide **50** will be permitted to advance to a new position by adjustment of stop **71** to redress the grinding wheel **51** on the next cycle. It should be noted that after the wheel **51** has been trued and the next workpiece is ground, the grinding wheel will just contact the cutter as it reaches the end of its stroke.

This system of controlling work size by proper placement of the wheel truing means has been accomplished herein by the use of a rotating dresser **60** engaging a rotating grinding wheel **51**, said dresser and wheel rotating in opposite directions and the provision of a workpiece-holding spindle which rotates the workpiece **15** in the opposite direction to the rotation of the wheel **51**.

In order to dress or true the internal grinding wheel **33**, it is withdrawn by the movement of the slide **30**, such that it is directly opposite the dressing wheel **39**. Thereafter, the slide **40** positions the dressing wheel **39** to engage the grinding wheel **33**. Additionally, by the provision of a fixed stop **81** and a mating adjustable stop **82** mounted on the screw **46**, the grinding wheel **33** may be fed into the work to a fixed position during the grinding operation or into the cutter **39** to the same fixed stop in final position for wheel truing or dressing. In practice, when the grinding wheel **33** is to be trued, stop **81** controlling the final infeed position of the internal grinding wheel **33** is preferably adjusted approximately .001 inch by adjustment of movable stop **82** with respect to the fixed stop **81**. In this manner the cutter **39** will remove approximately .001 inch from the outside radius of the grinding wheel **33** and the axis of the grinding wheel and its spindle will occupy a new position during both grinding and truing, which is removed from its previous position by the aforementioned .001 inch of feed. However, the working surface of the wheel will be in exactly the same position while grinding the next series of workpieces as it was before being trued or dressed.

As may be seen in FIG. 3, the inside diameter grinding wheel **33** and the outside diameter grinding wheel **51** are positioned to engage the workpiece **15**. FIG. 4 shows the inside diameter grinding wheel **33** axially moved to engage the dressing wheel **39** and the grinding wheel **51** is moved radially as the workpiece **15** is removed and replaced by the next workpiece within the spindle and pressure plate arrangement.

Referring now to FIG. 6, there is shown in schematic form an arrangement which may be used for operating the hydraulic cylinders **18**, **19**, **23** and **35**. At **90** there is provided a source of fluid which is pumped to a cylinder **91** by a pump **92**. The flow of fluid into the cylinder is controlled by a valve **94** having a movable spool **95** which is responsive to the position of a cam follower **96** and a cam **97**. By the use of a plurality of cams, the movements of the slides controlled by cylinders **18**, **19**, **23** and **35** may be controlled in a predetermined sequence. It should be understood that other hydraulic control systems well known in the prior art could also be used to control the aforementioned cylinders.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and since certain changes may be made in carrying out the foregoing method and construction set forth without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is to be understood that the following claims are intended to cover all the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A grinding machine adapted to grind the inside and outside diameters of a workpiece, comprising a first grinding wheel, means for rotating the first grinding wheel about its axis, a first cutter wheel, means for rotating the cutter wheel about its axis, first means for supporting and rotating a hollow substantially cylindrical workpiece, said first cutter wheel and said first means spaced less than 180° apart from each other about the circumference of the grinding wheel, means for positioning the

first grinding wheel to simultaneously engage the outside diameter of the workpiece, and said first cutter wheel, a second grinding wheel, means for rotating said second grinding wheel, and means for positioning said second grinding wheel in position to grind the inside diameter of said workpiece.

2. A grinding machine according to claim **1**, including a second cutter wheel and wherein said means for positioning said second grinding wheel positions said second grinding wheel to engage said second cutter wheel.

3. The grinding machine of claim **1**, wherein the axes of said workpiece and said first cutter wheel lie in substantially the same vertical plane.

4. A machine according to claim **1**, including stop means for setting the position of said grinding wheel with respect to said first cutter wheel and said first means.

5. In a machine according to claim **1**, wherein said first cutter wheel axis and the axis of rotation of said first means are equidistant from the horizontal plane passing through the axis of rotation of said grinding wheel.

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U.S. Cl. X.R.

51—89, 105; 125—11