Sept. 20, 1960 P. F. BARKER 2,952,948

GEAR GRINDING MACHINE

Filed April 18, 1958 3 Sheets-Sheet 1

FIG. 1

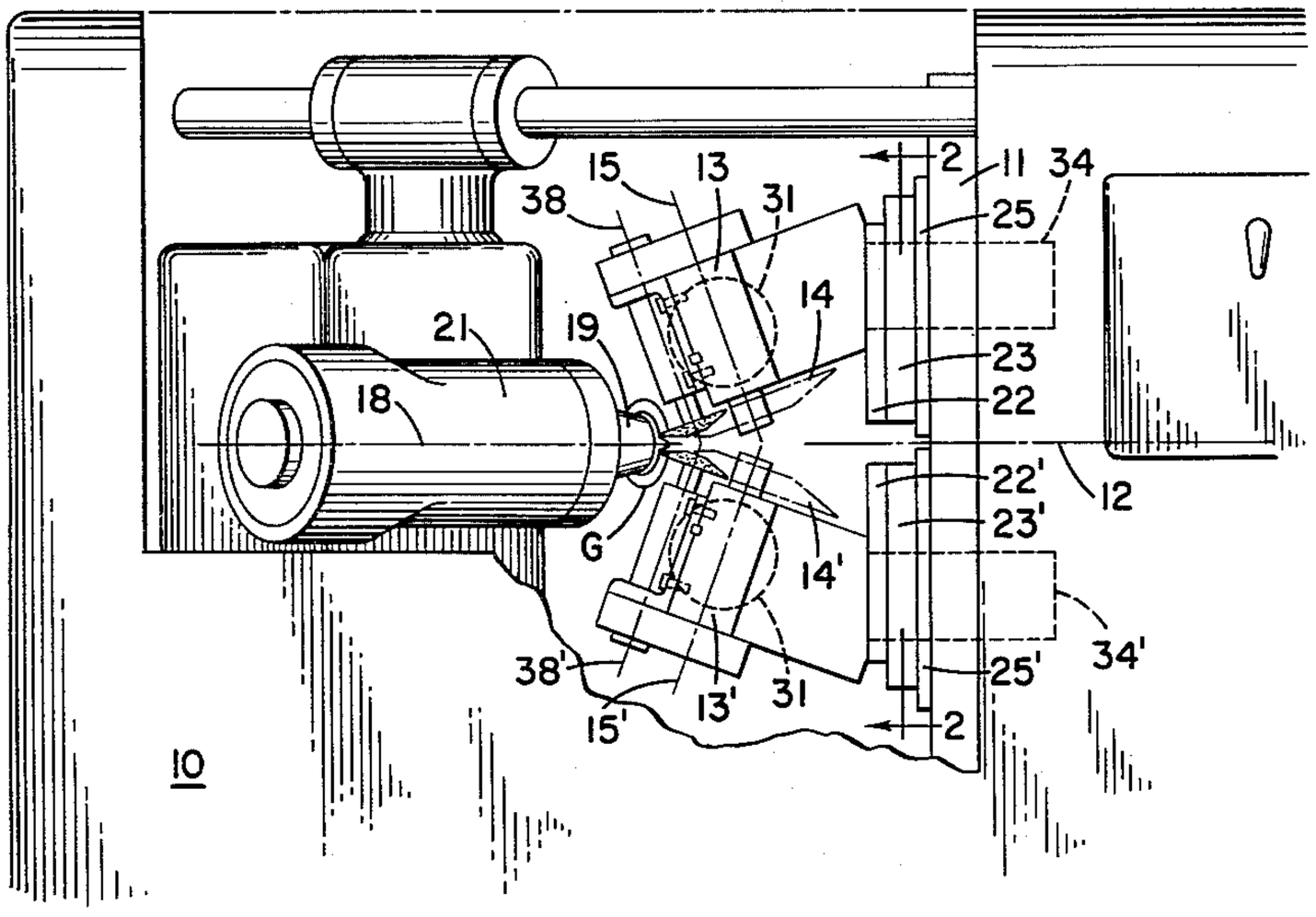
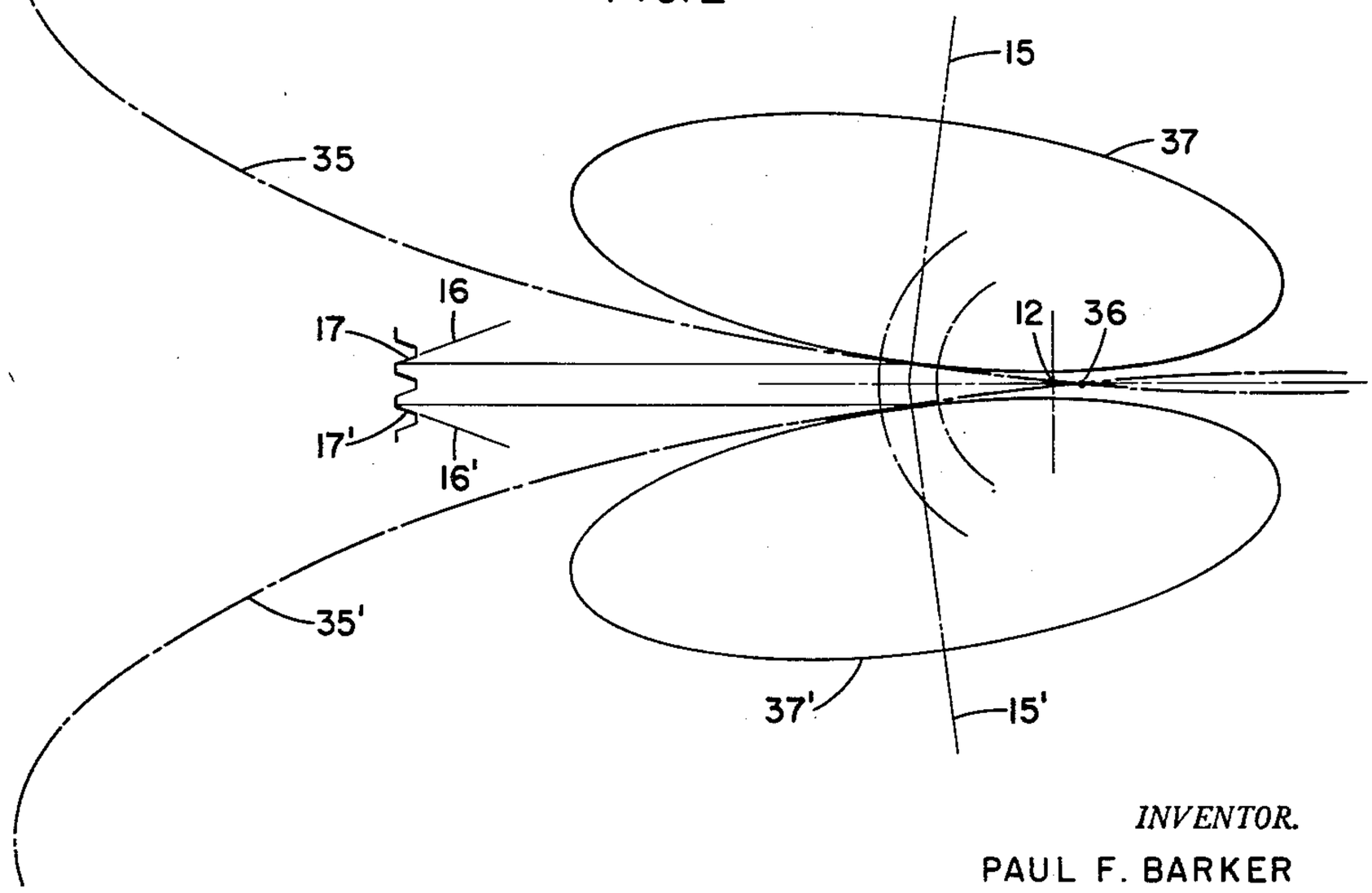


FIG. 2



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3 Sheets-Sheet 2

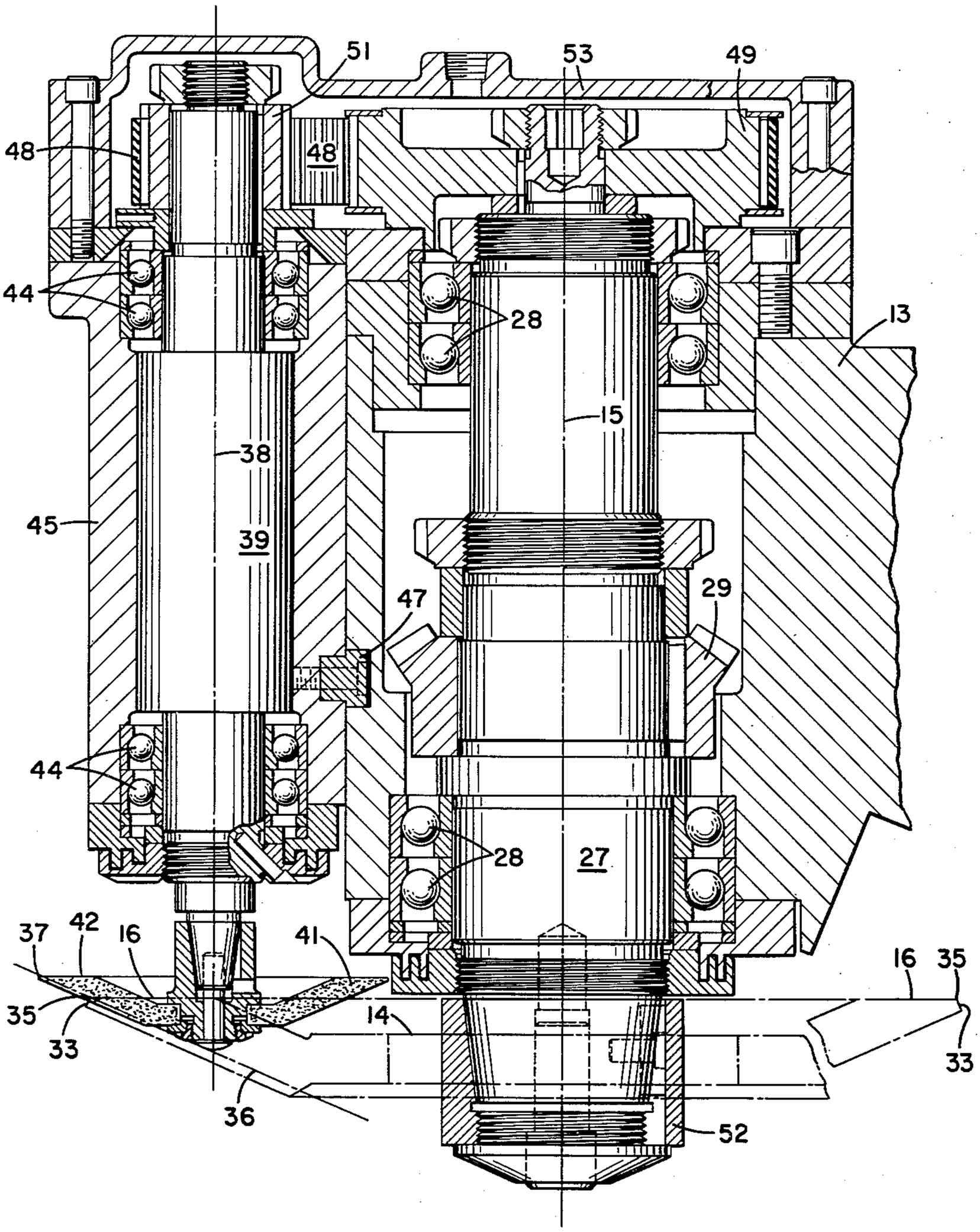


FIG. 3

Sept. 20, 1960 P. F. BARKER 2,952,948

GEAR GRINDING MACHINE

Filed April 18, 1958 3 Sheets-Sheet 3

FIG. 4

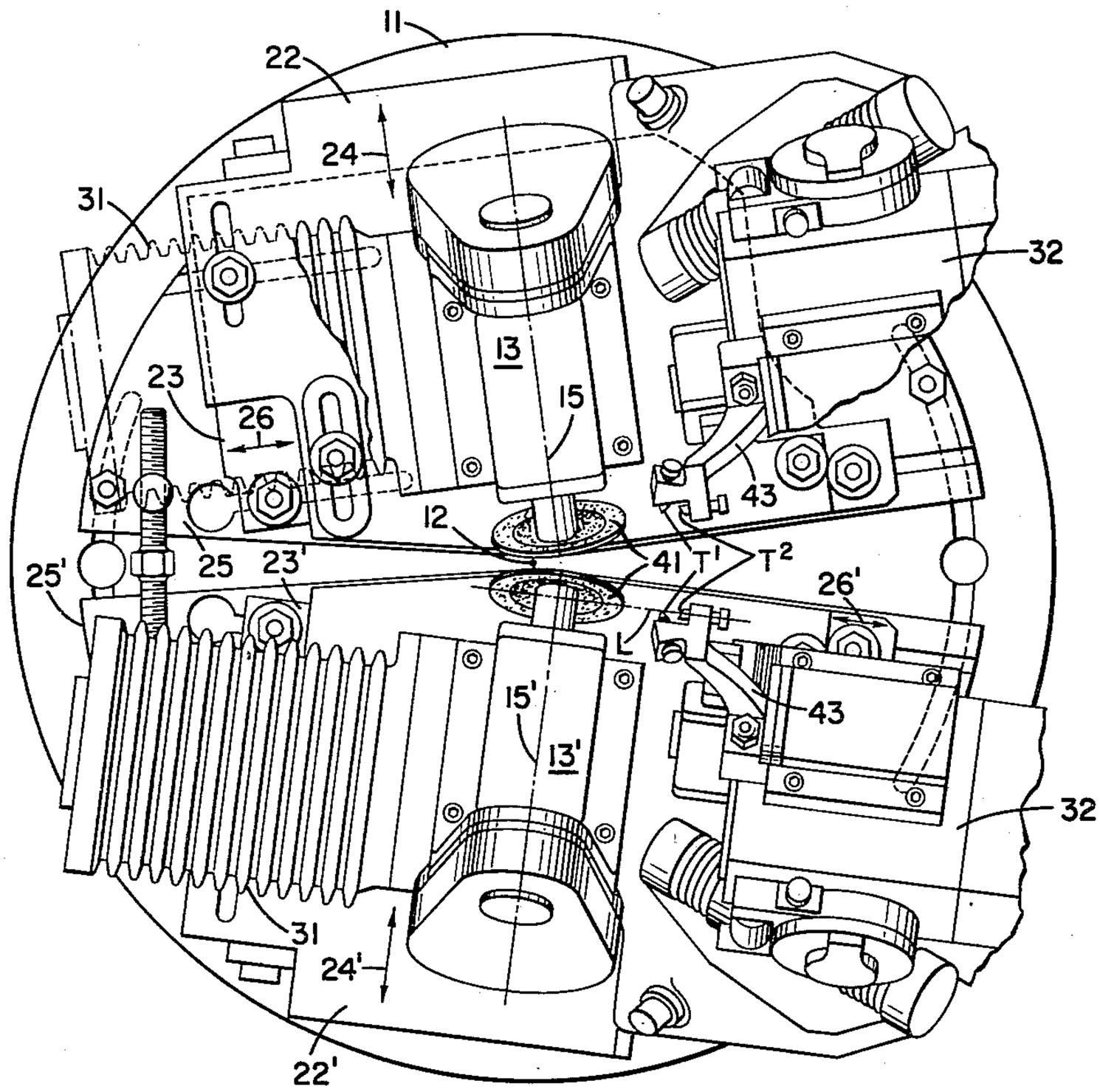
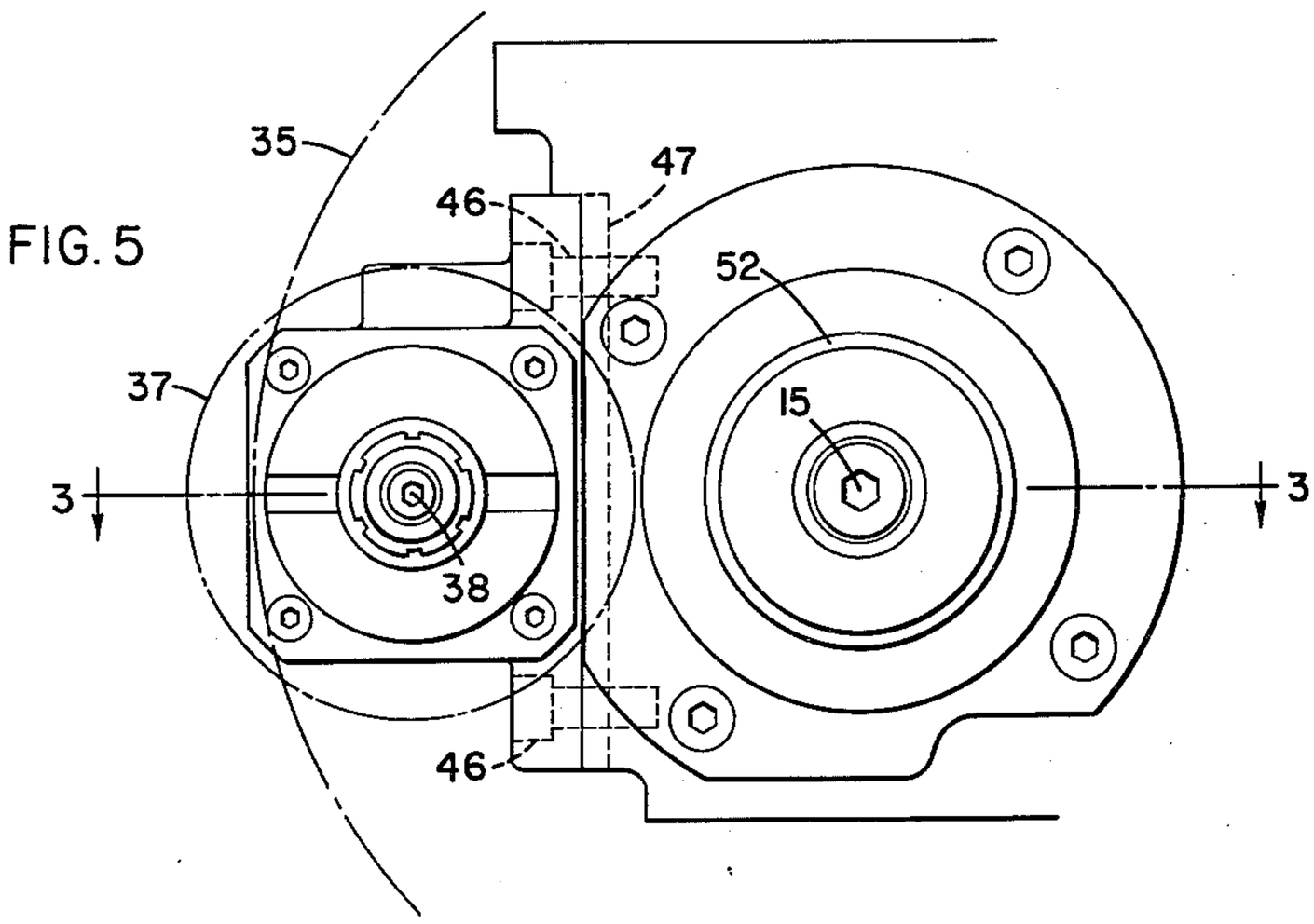


FIG. 5



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GEAR GRINDING MACHINE

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7 Claims. (Cl. 51—33)

The invention relates to machines for grinding gears, especially straight and skew bevel gears, of the kind wherein the grinding wheels have no stroking motion.

The purpose of the invention is to increase the capacity range of such machines, and, particularly, to enable them to grind gears of substantially smaller size than has been possible heretofore on a machine of given maximum capacity.

The machines employ a pair of disc-shaped grinding wheels supported by a rotary cradle, the working faces of the wheels being either plane or slightly dished and usually representing the remote sides of adjacent teeth of a generating gar. The abrasive whels are made as large in diameter as is feasible, in order to reduce both the rate of wheel wear and the concavity of the bottom lands of the ground tooth spaces. Consequently the wheel-carrying spindles and their housing or wheel heads are relatively large, commensurate in size with the grinding wheels used in producing gears falling in the upper part of the capacity range of the machine. Small diameter wheels suitable for grinding much smaller gears cannot be employed because the relatively large wheel heads and related parts interfere with the small gear and the machine work head which supports it. On the other hand large diameter wheels cannot be employed for grinding the small gear because such wheels would interfere with each other. Moreover the wheels for grinding fine pitch gears must have a very small point width or edge thickness, and large diameter wheels of such point width have been found to be inherently weak, leading to inferior surface finish of the ground gears.

By the present invention the capacity range of the machine is materially extended, and the problems of wheel interference and wheel weakness are obviated. A machine according to the invention comprises a rotatable cradle, a wheel head mounted on the cradle and projecting forwardly beyond the front face of the cradle, first and second spindles rotatably supported by the head and adapted to carry disc-shaped abrasive grinding wheels of large and small diameter, respectively, the second spindle being forward of and parallel to the first, and the spindles being inclined at an acut angle to the plane of rotation of the cradle and said spindles both being disposed in the same plane perpendicular to said plane of rotation. Preferably the second or auxiliary spindle is journaled for rotation in a housing which is detachably secured to the head, so that it may be removed when a grinding wheel is to be mounted on the first spindle. Also a belt and pulley drive connection between the spindles preferably is provided, this connection being of such ratio that the peripheral speed of the wheel will

be the same irrespective of whether the wheel being used is of small or large diameter.

The preferred embodiment of the invention is shown in the accompanying drawings, wherein:

Fig. 1 is an elevation of the machine;

Fig. 2 is a diagram on a larger scale, showing the working faces of the grinding wheel as viewed from plane 2—2 of Fig. 1;

Fig. 3 is a sectional view through the wheel head, and the housing for the second spindle, in the plane of the spindle axis, the plane being designated 3—3 in Fig. 5;

Fig. 4 is a face view of the cradle and of the parts carried thereby; and,

Fig. 5 is a bottom plan view of the structure shown in Fig. 3.

The major portion of the machine is like that of L. O. Carlsen et al. Patent 2,792,672, granted May 21, 1957. It comprises a frame 10 on which a cradle 11 is rotatable back and forth about a horizontal axis 12. Mounted adjustably on the cradle and projecting forwardly from the cradle's front face are two wheel heads 13 and 13′ each adapted to support a disc-shaped grinding wheel, 14 or 14′, for rotation about an axis, 15 or 15′, that is inclined at an acute angle to the plane of rotation of the cradle, which is parallel to plane 2—2. The working face 16 or 16′ of each wheel is plane or very slightly dished or concaved, i.e. its generatrices are either perpendicular to the respective axis 15 or 15′ or inclined to such axis at an angle of about 86° to 88°. As shown in the projection at the left in Fig. 2 the working faces of the wheels represent the upper and lower tooth sides, 17 and 17′ respectively, of a generating gear which during the grinding operation rolls in mesh with the work gear G. That is, referring to Fig. 1, the work gear rotates about its axis 18 in a predetermined velocity ratio with rotation of the generating gear about its axis 12, the cradle axis. The work gear is supported on a spindle 19 journaled in work head 21 for rotation about the horizontal axis 18. The work head is adjustable angularly on the frame 10 about a vertical axis which intersects the axes 12 and 18 at their point of intersection, and it is also movable on the frame in the direction of cradle axis 12 to bring the work gear into and out of grinding position.

In order that the grinding wheels can be made to represent a generating gear of whatever diameter and pitch is wanted, the wheel heads 13, 13′ are adjustable relative to each other about the cradle axis and also in directions perpendicular to that axis. For this purpose the wheel heads are carried respectively by slides 22, 22′ which are adjustable vertically on horizontal slides 23, 23′, in the direction of arrows 24, 24′, i.e. in a direction parallel to the plane of cradle rotation and also parallel to the pendicular plane which contains the wheel axis 15 or 15′. The horizontal slides in turn are respectively adjustable upon plates 25, 25′ in the direction of arrows 26, 26′, i.e. in the direction parallel to the plane of cradle rotation and perpendicular to the respective wheel axes. The plates 25, 25′ are angularly adjustable on the cradle about the cradle axis 12.

Each grinding wheel 14, 14′ is mounted on a spindle 27 that is journaled on anti-friction bearings 28 in the related wheel head 13 or 13′, and is driven through bevel gears 29 by a motor 31 secured to the wheel head. Also secured to each wheel head is a dresser unit 32

(omitted from Fig. 1) for dressing the working face **16** and the tip face **33** of the grinding wheel. To compensate for diameter changes of the wheel the supporting parts **34** and **34'** of the heads **13**, **13'** are arranged for feed motion in the vertical slides **22** and **22'** in the direction of the cradle axis **12**. As disclosed in aforementioned Patent 2,792,672 suitable feed means are provided to feed the dresser unit on the wheel head simultaneously with the feed motion of the head. The dresser feed is in such direction, in a plane perpendicular to that of Fig. 3, that as stock is dressed from the faces **16** and **33** of the wheel the periphery **35** of the working face recedes relative to the wheel head at least approximately along a line **36** which lies in the plane of Fig. 3 and is parallel to the cradle axis.

The problem leading to the present invention is that if an attempt is made to adjust the wheel heads **13**, **13'** to a position suitable for grinding a small gear, for example a position in which the working faces **16**, **16'** of the wheels will represent the generating gear tooth surfaces **17**, **17'** shown in the projection at the left of Fig. 2, an interference will develop between the two wheels. That is, referring to the main part of Fig. 2, looking in the direction of cradle axis **12**, it will be seen that the peripheries **35**, **35'** of the wheels would intersect at point **36**. The only solutions for this problem are to remove one wheel or to reduce the wheel diameters. For example, as shown in Fig. 2, the working-face peripheries **37**, **37'** of small diameter wheels are clear of each other by a substantial distance when such wheels are adjusted to represent the same generating gear tooth surfaces **17**, **17'**. However, it has been found impossible to mount such small wheels on the spindles **27**, and still bring the work head **21** and work gear G into proper position for grinding, because of interference with the relatively large size of the spindles necessary for grinding larger gears with wheels **14**, **14'** and with the correspondingly large sized heads **13**, **13'** and related parts, including dresser units **32**.

According to the invention an auxiliary spindle for a small grinding wheel is provided on each wheel head, such spindle being disposed forwardly of the spindle **27** and having its axis, **38** or **38'**, inclined to the plane of rotation of the cradle at the same acute angle as the respective spindle axis **15** or **15'**. The axes **38** and **15** lie in the same plane perpendicular to the plane of rotation of the cradle, and the same is true of axes **38'** and **15'**. In Fig. 3 the upper auxiliary spindle unit only is shown, and it will be understood that the lower unit is similar but of opposite hand. The unit shown includes auxiliary spindle **39** which is of smaller size than spindle **27**, commensurate with the small size of the wheel **41** it carries, and is so positioned that the periphery **37** of the working face **42** of the wheel contacts the same line **36** that touches, or nearly touches, the periphery **35** of the large wheel **14**. Consequently the same dresser unit **32** and dresser feed mechanism may be employed, although a different arm **43** must be provided on the dresser to carry the wheel side and tip dressing tools **T–1** and **T–2** thereof, since the tools must operate in a different plane than the dressing tool for the large wheel. The dressing tool **T–1** for the small wheel must operate in the line L which is parallel to the plane of rotation of the cradle and intersects the axis **38** whereas the tool for the large wheel must operate in a parallel line, not shown, intersecting axis **15**. With either size of wheel the same machine gaging devices or calibrations used in connection with adjustment of the wheel heads may be employed since as considered in the plane of Fig. 3 the periphery **37** of the small wheel occupies the same position (along line **36**) that the peripheral edge **35** of an over diameter wheel **14** might occupy. The dressing tools **T–1** and **T–2** have only a reciprocating motion in the direction of line L, the tool **T–1** being effective during such reciprocation and the tool **T–2** only contacting the wheel periphery at the conclusion of the inward stroke of the tool arm **43**.

The auxiliary spindle **39** is journaled in anti-friction bearings **44** in a housing **45** that is detachably secured to the wheel head **13** by screws **46**, Fig. 5, the housing being precisely located by a key **47**. Spindle **39** is driven by a toothed endless belt **48** which runs over toothed pulleys **49** and **51** detachably secured to the spindle **27** and the spindle **39**, respectively. The diameter ratio of pulley **49** to pulley **51** is approximately equal to that of wheel **14** to wheel **41** so that the peripheral speeds of the wheels will be about the same. When the small wheel **41** is in use the nose of spindle **27** is covered by a detachable protective sleeve **52**, and a detachable cover **53** is secured to the head **13** over the pulleys. When the large wheel **14** is used, replacing the sleeve **52** on spindle **27**, the auxiliary spindle and housing unit **45**, **39**, **47** and the pulley **48** are removed; and the cover **53** is replaced by a smaller one suitable for protecting the adjacent end of spindle **27**.

From the foregoing description it will be understood that the invention greatly extends the capacity range of the machine without requiring any replacement of the wheel heads **13**, **13'**, or of the adjusting and feed mechanism thereof, including the calibrating or gaging instrumentalities, or of other major components of the machine.

It will also be understood that the foregoing disclosure is made by way of illustration and presently preferred example of the inventive principles involved, and that these principles may be applied to machines of other design and arrangement without departing from the spirit of the invention or from the scope of the appended claims.

What I claim as my invention is:

1. A gear grinding machine comprising a rotatable cradle, a wheel head mounted on the cradle and projecting forwardly beyond the front face of the cradle, first and second spindles rotatably supported by the head and adapted to carry disc-shaped abrasive grinding wheels of large and small diameter, respectively, the second spindle being forward of and parallel to the first, and the spindles being inclined at an acute angle to the plane of rotation of the cradle and said spindles both being disposed in the same plane perpendicular to said plane of rotation.

2. A gear grinding machine comprising a rotatable cradle, a wheel head mounted on the cradle and projecting forwardly beyond the front face of the cradle, first and second spindles rotatably supported by the head, with the second spindle forward of and parallel to the first and both spindles inclined at an acute angle to the plane of rotation of the cradle, the first and second spindles being adapted to carry disc-shaped grinding wheels of large and small diameter, respectively, each having an approximately plane working face for grinding the tooth sides, the spindles being so related to each other that the peripheries of the working faces of both wheels may be in approximately normal intersecting relation to a line which parallels the cradle axis and lies in the plane common to the axes of both spindles.

3. A machine according to claim 2, in which the wheel head is mounted in the cradle for feed movement in the direction of the cradle axis to compensate for diameter changes of the grinding wheel.

4. A machine according to claim 1 in which there is a drive means for the first spindle, and a drive connection between the spindles of such ratio that the second spindle will rotate at higher angular velocity than the first.

5. A machine according to claim 1 in which the first spindle is journaled for rotation in the wheel head, and the second spindle is journaled for rotation in a housing which is detachably secured to the head.

6. A machine according to claim 1 in which there are two such wheel heads mounted on the cradle, each head rotatably supporting a said first spindle and a said second spindle.

7. A machine according to claim 6 in which there are means for adjusting the heads on the cradle relative to each other about the cradle axis and also in directions perpendicular to said axis whereby either large diameter grinding wheels on the first spindles or small diameter grinding wheels on the second spindles may be positioned to represent opposite sides of spaced teeth of a generating gear whose axis is the cradle axis.

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