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[54] **GEAR TREATMENT APPARATUS**

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[52] **U.S. Cl.** ..... **51/89,** 51/99, 51/105 R, 51/287

[51] **Int. Cl.** **B24b 5/36**

[58] **Field of Search** ..... 51/105 R, 131, 89, 51/287, 99; 15/21 R, 21 D, 21 E

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[57] **ABSTRACT**

A gear treatment apparatus, including a workhead for supporting and rotating a gear and a wheelhead having an abrasive wheel resiliently pressed against the gear.

4 Claims, 8 Drawing Figures

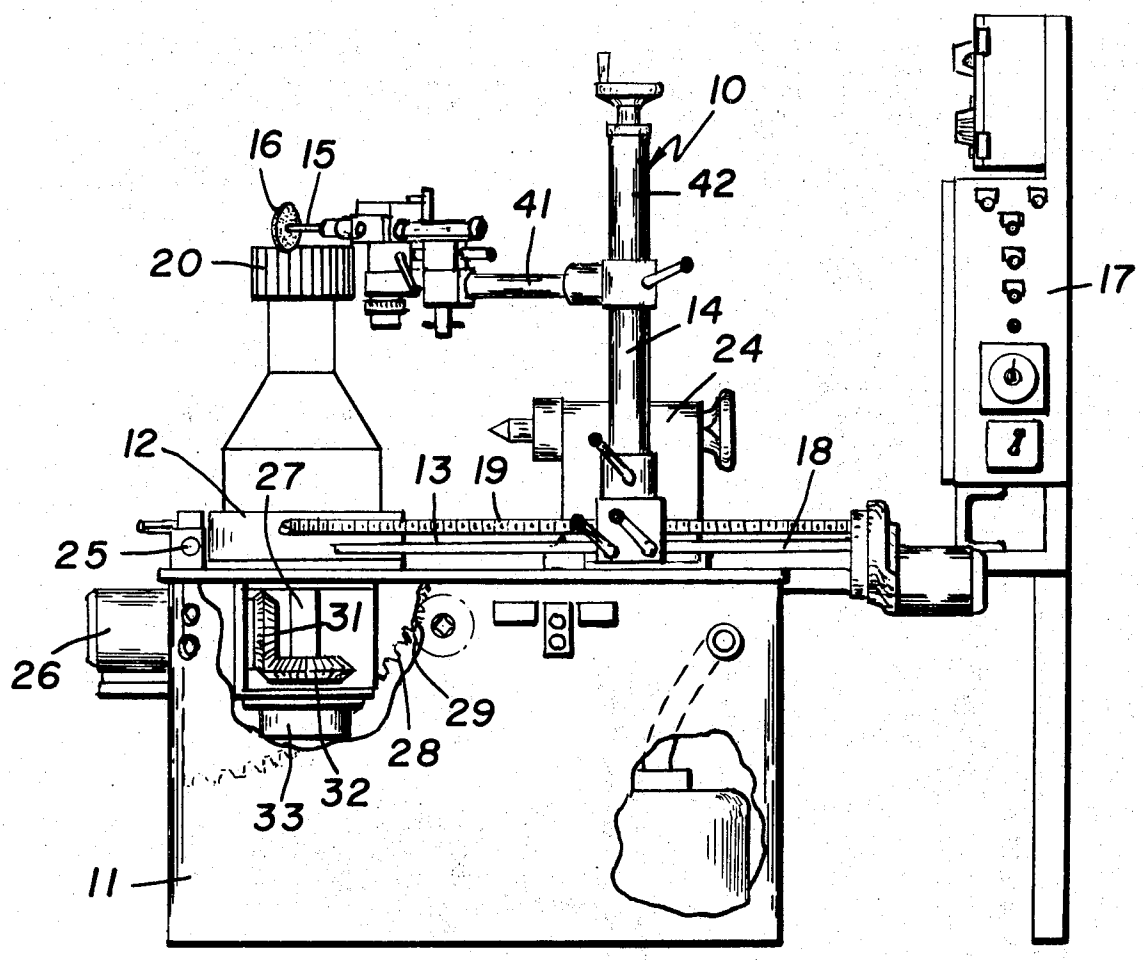
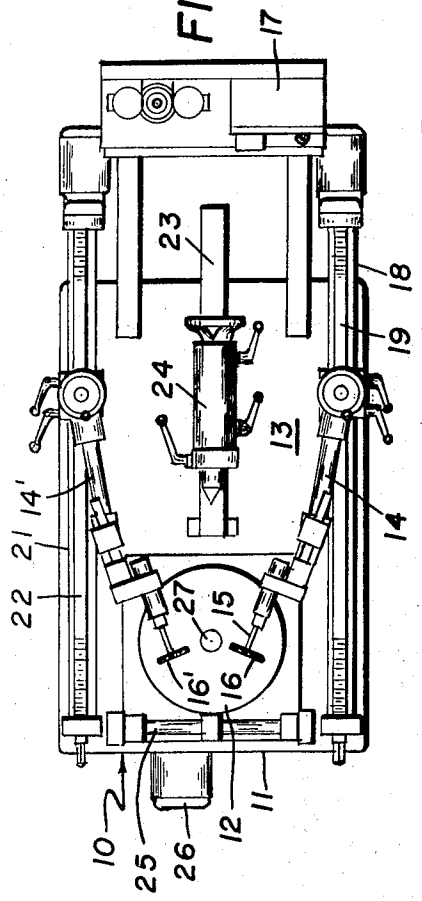


FIG. 3



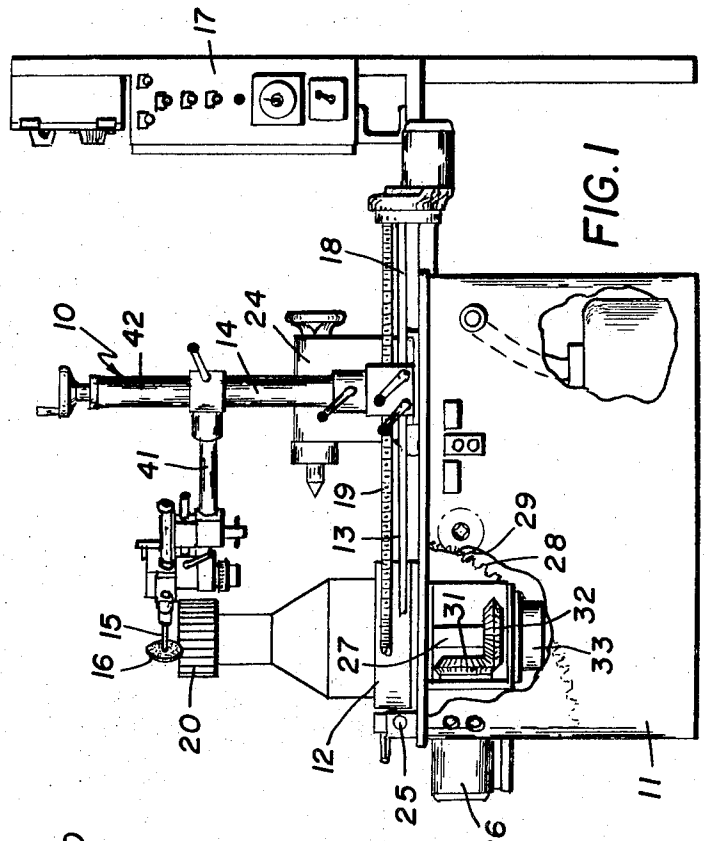


FIG. 1

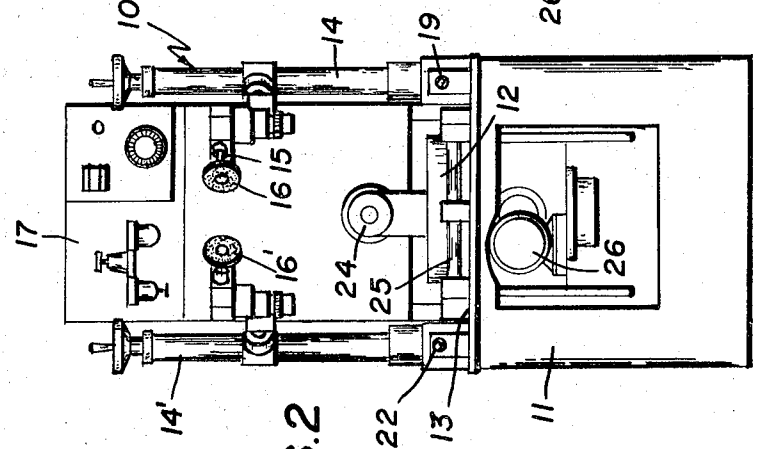


FIG. 2

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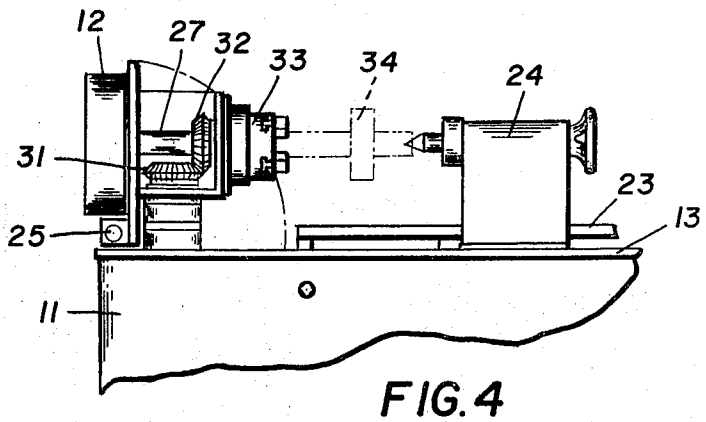


FIG. 4

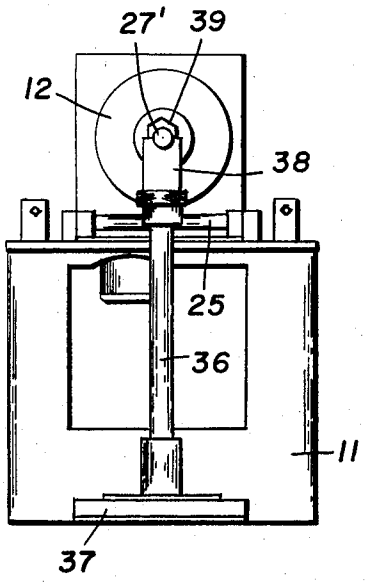


FIG. 5

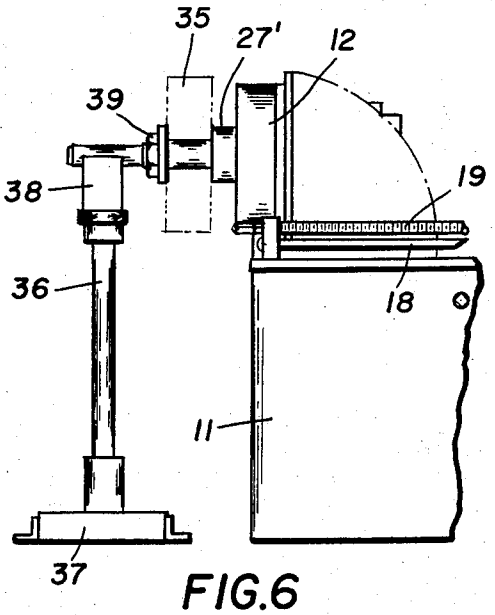


FIG. 6

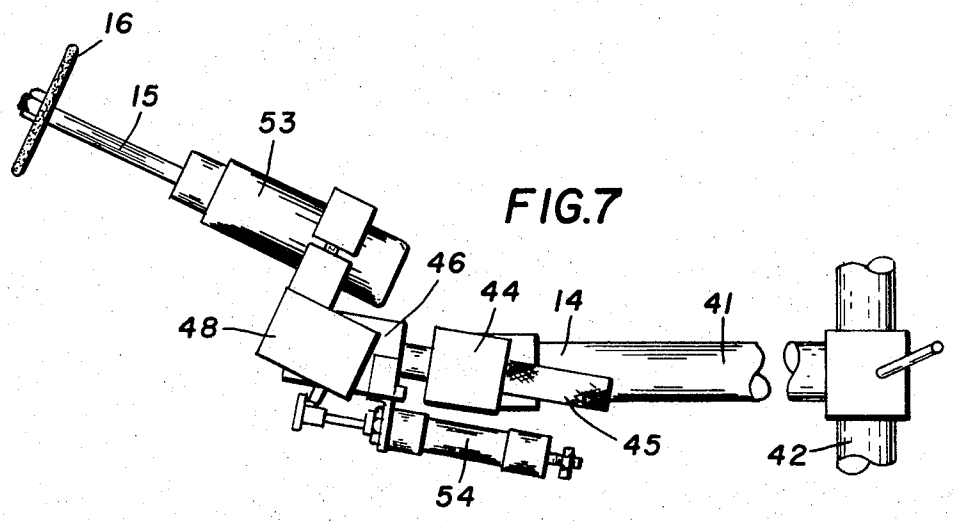

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FIG.7

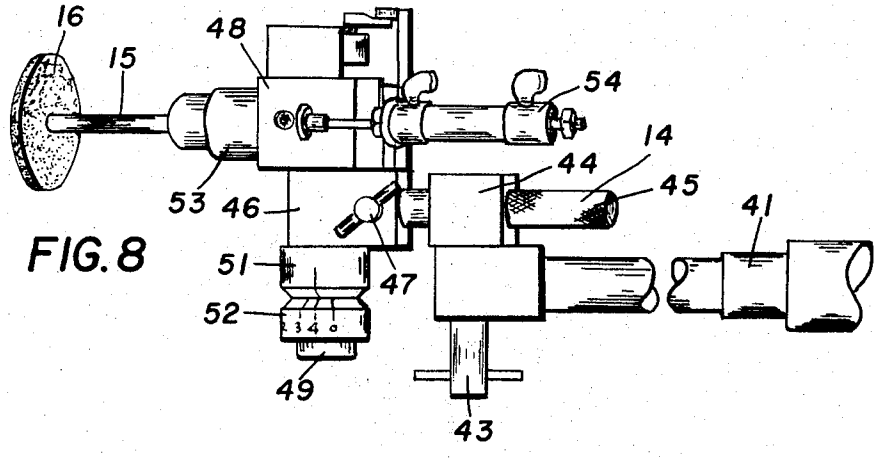

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FIG.8

GEAR TREATMENT APPARATUS

BACKGROUND OF THE INVENTION

In the manufacture of gears, after the involute surfaces have been formed, it is common practice to bevel the end edges, i.e., the edges between the intersection of the involute surfaces (flanks) and the radial surfaces of the gear. The type of bevel that is produced is usually determined by the ultimate use of the gear. Sometimes, the only bevel that is necessary is one which is sufficient to remove any burrs from the machine elements. In other cases, the bevel must be quite substantial to assist the gear in sliding in the axial direction into engagement with another gear, as is true in the case of automotive transmissions. Such bevels are known by various names usually associated with the type of bevel and its ultimate use; for instance, these operations are known as deburring, bullet-nosing, and the like. Deburring may take place, for instance, by placing the gear in a tumbling barrel with abrasive elements or by holding it by hand against a rotating steel brush. When more substantial bevels are to be produced on the end of the gear, it is necessary to file them by hand. In any case, all of the prior art processes have suffered from the deficiency that they were hand operations and, therefore, very expensive. Furthermore it has been difficult to obtain the same degree of beveling from gear to gear because of human error. These and other difficulties experienced with the prior other devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide gear treating apparatus for automatically beveling the edges of a gear.

Another object of this invention is the provision of gear treating apparatus for providing the same amount and type of bevel from workpiece to workpiece.

A further object of the present invention is the provision of apparatus for finishing the edges of gears which will permit the reduction of cost of the operation because of the fact that manual labor is used only in setting up the gear but not in the beveling operation itself.

It is another object of the invention to provide apparatus for beveling gears that operates almost entirely by the removal of metal without any substantial forging or production of additional burrs.

A still further object of the invention is the provision of apparatus for beveling gears in which opposite flank edges on the same end of a gear-tooth or opposite end edges of the gear may be beveled at the same time.

It is a further object of the invention to provide gear treatment apparatus which may be used alternatively for the beveling of small gears, for the beveling of gears of very large radius, or for the beveling of gears which are formed in the intermediate portions of shafts.

It is a still further object of the present invention to provide apparatus for contouring the edges of all types of gears including spur, bevel, spiral-bevel, spherical, and pinion gears, irrespective of the geometric shape of the flanks.

SUMMARY OF THE INVENTION

In general, the invention consists of a gear treatment apparatus having a base on which is mounted a workhead, including a spindle on which a gear can be mounted for rotation about its axis. The wheelhead is also mounted on the base and has a rotatable spindle on which abrasive wheels can be mounted. Means is

provided for pressing the spindle resiliently in the direction of the gear so that the surface of the abrasive wheel cams its way along the gear edge.

More specifically, the spindle is driven at high speed by a turbine-type pneumatic motor. The workhead is swingably connected to the base to allow it to be used at various angular relationships to the wheelhead The wheelhead spindle is mounted for swinging action about an axis at a right angle to the spindle axis. The base is provided with two sets of parallel ways mounted along the side edges of the surface of the base and a wheelhead is mounted on each of the ways and provided with a screw-type driving means. A secondary set of ways is mounted at one end of the base between the two previously mentioned sets and the tailstock is mounted on the secondary set of ways.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of apparatus embodying the principles of the present invention,

FIG. 2 is an end elevational view of the apparatus,

FIG. 3 is a plan view of the apparatus,

FIG. 4 is a side elevational view of the machine showing it in condition for beveling gears mounted on an elongated shaft,

FIG. 5 is an end elevational view of the machine in condition for beveling a gear of large diameter,

FIG. 6 is a right elevation of the machine showing it when in use in the operation shown in FIG. 5,

FIG. 7 is a plan view of the wheelhead, and

FIG. 8 is a front elevational view of the wheelhead.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIGS. 1, 2, and 3, which best show the general features of the invention, the gear treatment apparatus, indicated generally by the reference numeral 10, is shown as consisting of an elongated rectangular base 11 having an upper horizontal surface 13 at one end of which is mounted a workhead 12. Mounted at one side of the base 11 and extending from the surface 13 is a wheelhead 14 having a spindle 15 on which is mounted an abrasive wheel 14'. A similar wheelhead 16 is located at the other side of the base. At the end of the base opposite the workhead 12 is a control box 17.

The wheelhead 14 is slidably mounted on a way 18, which extends along one long side of the base and is propelled along that way by a motor-driven screw 19. A similar way 21 and screw 22 is located along the other side of the base to support and move the wheelhead 16. Mounted on the surface 13 of the base 11 and parallel to and lying between the ways 18 and 21 is a set of ways 23 on which is slidably mounted a tailstock 24. In FIG. 1 a typical gear 20 is shown being finished, but it has been omitted from FIGS. 2 and 3 for clarity of presentation. The wheelhead 12 is shown as mounted on a hinge shaft 25 for movement about an axis extending across the base 11 perpendicular to the ways 18 and 21 and extending in a horizontal direction. Extending from the workhead is a spindle 27 driven by a direct current electric motor 26. Workhead 12 is tiltable above the shaft 25 by means of a gear segment 28 operable by hand with the use of a crank on a pinion 29. As is evident in FIG. 1, the spindle 27 is driven by the motor 27 through a pair of bevel gears 31 and 32. Spindle 27 is keyed to the beveled gear 32 and extends

from each side, terminating on one side in of the workpiece and workhead **12** , and terminating on the other side in chuck **33.**

In FIG. **4** it can be seen that the workhead **12** has been rotated 90° from the position shown in FIG. **1,** so that the shaft **27** is horizontal and the chuck **33** is aligned with the tailstock **24.** It is then possible to mount a pinion gear **34** with the chuck **33** grasping one end of the pinion gear shaft and the tailstock **24** having its freely-rotatable center lying in a suitable center at the other end of the pinion gear shaft.

FIGS. **5** and **6** show the apparatus in use with a gear **35** having a very large diameter. For this purpose, the workhead is turned 90° from its condition in FIG. **1,** so that the spindle **27** is horizontal and a spindle extension **27'** is used. At the outboard end of this extension, a floor station **36** is provided. The stanchion has a broad base **37** which rests on the floor beside the base **11** and, at its upper end, it carries a cradle **38** which supports the outboard end of the spindle extension **27'** while allowing it to rotate. The gear **35** is held against a shoulder on the spindle extension by a large washer and nut **39.** Because of the fact that the way **18** and the feed screw **19** extend to the extreme end of the base **11,** it is possible to bring the wheelheads **14** and **14'** to the area of the gear **35** to bring about the grinding operation.

FIGS. **7** and **8** show the details of the wheelhead **14.** A generally horizontal arm **41** is vertically adjustable along a vertical post **42** which is slidably mounted on the way **18** and movable by means of the feed screw **19** (see FIG. **1**). At the other end of the arm **41** is provided a hinge pin **43** which allows an angular adjustment about a vertical pivot of a block **44.** Means is provided to lock the block **44** in this position of adjustment relative to the arm **41.** The arm **41** can also be locked in its vertical position along the post **42.** Extending horizontally through the block is a rod **45** having mounted on it for rotation about a horizontal axis, (which is the axis of the rod) a block **46** having a suitable locking handle **47.** A block **48** is mounted on top of the block **46** and is fixed to a vertical rod **49** which extends downwardly through the block **46** and is mounted in bearings therein. In other words, the block **48** is rotatably mounted on the block **46** and an internal coiled flat spring is fastened at its inner end to the rod **49** and, at its outer end, to the block **46.**

The block which carries the outer end of the coil spring is provided with a collar **51** having a locating mark, while the rod **49** is provided with a numbered collar **52** which can be rotated to adjust the tension in the spring. The spindle **15** carrying the abrasive wheel **16** is rotatably carried in a turbine-type pneumatic motor **53** which is mounted on the block **48** and is carried with it. Extending between the block **46** and the block **48** is a linear actuator, such as a pneumatic cylinder **54.** Suitable pneumatic lines extend from the control box **17** to the motor **53** and the cylinder **54,** but these have been omitted from the drawings for the purpose of clarity of presentation.

The operation of the apparatus will now be readily understood in view of the above description. Assuming that a gear **20** is mounted for rotation about a vertical axis in the manner shown in FIG. **1,** the wheelhead **14** is operated by actuation of the motor rotating the feed screw **19,** so that the wheehead is advanced along the ways **18** to a position where the abrasive wheel **16** is adjacent the edges of the gear. The angularity of the gear and the wheel can be very carefully selected by a combination of rotating the workhead **12,** about its hinge axis **25** by means of the gear segment **28** and actuating the pinion gear **29.** The abrasive wheel **16** receives angular adjustment relative to the gear teeth and the gear axis by moving the block **44** relative to the arm **41.** By proper selection of these angular adjustments, it is possible to produce the operation on the gear edge either with the periphery of the wheel **16** or with the radial surface of the wheel adjacent the periphery. This would give the type of operation on the gear edge that is desired in a particular situation. It is thus possible to obtain a bevel or simply a de-burring operation, as well as bullet nosing and other desired gear edge forms. By bringing the secondary wheelhead **14'** into operation on the other side of the gear it is possible to have the wheel **16'** climb up one flank edge and fall down the other flank edge of a given tooth, while the abrasive wheel **16** climbs up the second flank edge and falls down the first flank edge. The net result of this is simultaneous grinding of both flank edges of the gear tooth. Furthermore, if desired, the wheel **16** can operate on the top edge of the gear, while the abrasive wheel **16'** operates on the bottom edge, so that a gear can have both ends of its teeth beveled or rounded at the same time.

In the preferred embodiment, the control box **17** allows for a multiple number of rotations of the gear during a given cycle. It may be desirable, for instance, in some situations, to rotate the gear several times past the wheels to provide the desired beveling. In that case, the control automatically counts the number of rotations before the cylinder **54** is actuated to rotate the spindle away from the gear at the end of the cycle. In the preferred embodiment, the control box also contains an interlock to assure that the spindle is maintained in the outward inoperative position away from the gear until the gear begins rotating and until the pneumatic motor **53** has come up to speed. Engagement of the abrasive wheel with the gear before the wheel is going at the ideal speed damages both the wheel and the gear. One of the advantages of the present invention is that the wheelheads **14** and **14'** can be moved quickly to the other end of the base out of the way for loading and unloading. To do this it is only necessary to actuate the control button on the control box which operates the motors which drive the feed screws **19** and **22.** It can be understood that a machinist can operate several of these machines at the same time, so that he simply loads one machine and leaves it to produce the rounding operation on the gear, while he goes on to the next machine and loads it. In this way, it is not necessary for an operator to be present at each machine during the entire operation. He is able to handle several machines and the cost of labor in rounding a given gear is quite low. In this way, too, the bevel on the gear edge is the same for all gears, since the parameters have been set up to give equal pressure, speed, and so on between the wheel and the gear in each case. Excellent repeatability of gear edge bevel shape is possible. Because of this it is possible to design transmissions with the assumption that the leading or sliding of the one gear into another will be the same from transmission to transmission because of the standardization of the bevel. Because of the unusual construction of the workhead, it is possible to use a single machine on al-

most any kind or size of gear, so that it is not necessary to tie up the capital investment in the machine shop in more machines than can be operated at any given time. It also should be noted that it is possible not only to bevel the entire edge of the end of the gear, but also simply to knock off the corner edge at the intersection between the flank and the end of the gear; that is to say, the corner. Also, by carefully selecting the angularity between the axis of the abrasive wheel and the axis of the gear, it is possible to bevel one side edge of a tooth without the abrasive wheel striking the other flank of the next adjacent tooth.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

I claim:

1. Gear treatment apparatus for treating a gear having a shape, comprising:

a. a base,

b. a workhead mounted on the base and including means to support the gear and rotate it about its axis, the workhead being provided with a motor-driven first spindle on which the gear is mounted, and the workhead also including a hinge located a substantial distance from the spindle axis and at a right angle thereto,

c. a wheelhead mounted on the base and including a second spindle on which is mounted an abrasive wheel and a motor for driving the second spindle,

d. means associated with the wheelhead to press the wheel toward the gear so that the wheel follows the shape of the gear as the gear rotates.

2. Gear treatment apparatus as recited in claim **1**, wherein the workhead is movable from a first position at which the first spindle is vertical to a second position at which the first spindle is horizontal.

3. Gear treatment apparatus as recited in claim **2**, wherein in the second position a secondary spindle also extends horizontally, but in the opposite direction, and wherein a tail stock is slidably mounted on the base for use with the secondary spindle to mount a gear on centers.

4. Gear treatment apparatus, comprising:

a. an elongated rectangular base having a generally flat horizontal upper surface having two long side edges,

b. a workhead mounted at one end of the base and having a motor-driven spindle on which a gear can be mounted and rotated,

c. a set of ways mounted along each long side edge of the surface of the base,

d. a wheelhead slidably mounted on each set of ways and including a spindle on which an abrasive wheel is mounted,

e. means associated with each wheelhead to press the wheel resiliently toward the gear,

f. a secondary set of ways mounted at the other end of the base between the two previously-mentioned sets, and

g. a tail stock mounted on the secondary set.

* * * * *