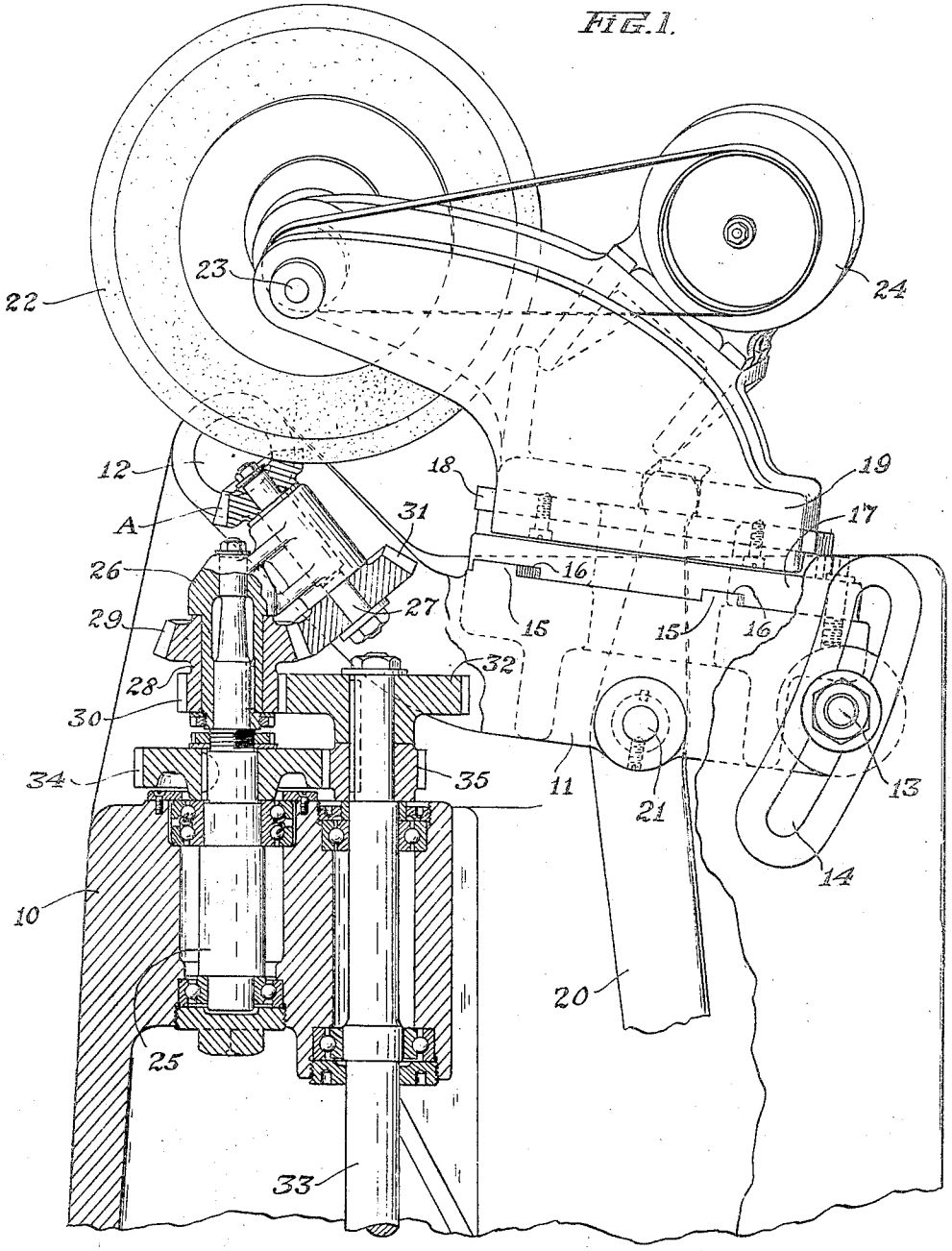
Feb. 14, 1928. 1,659,224

S. J. TELLER

BEVEL GEAR GRINDER

Filed July 31, 1924 3 Sheets-Sheet 1

FIG. 1.



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3 Sheets-Sheet 2

FIG. 2.

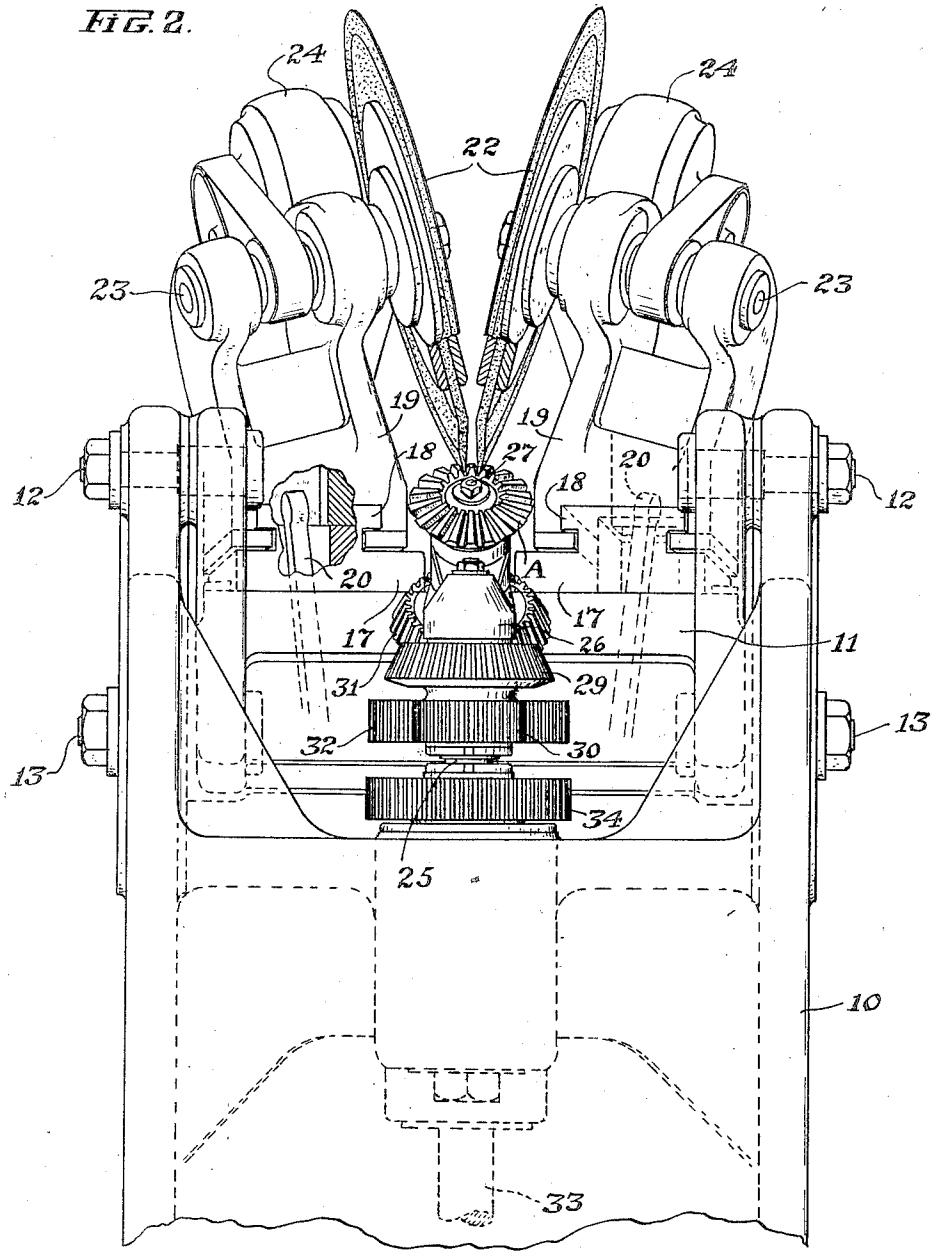

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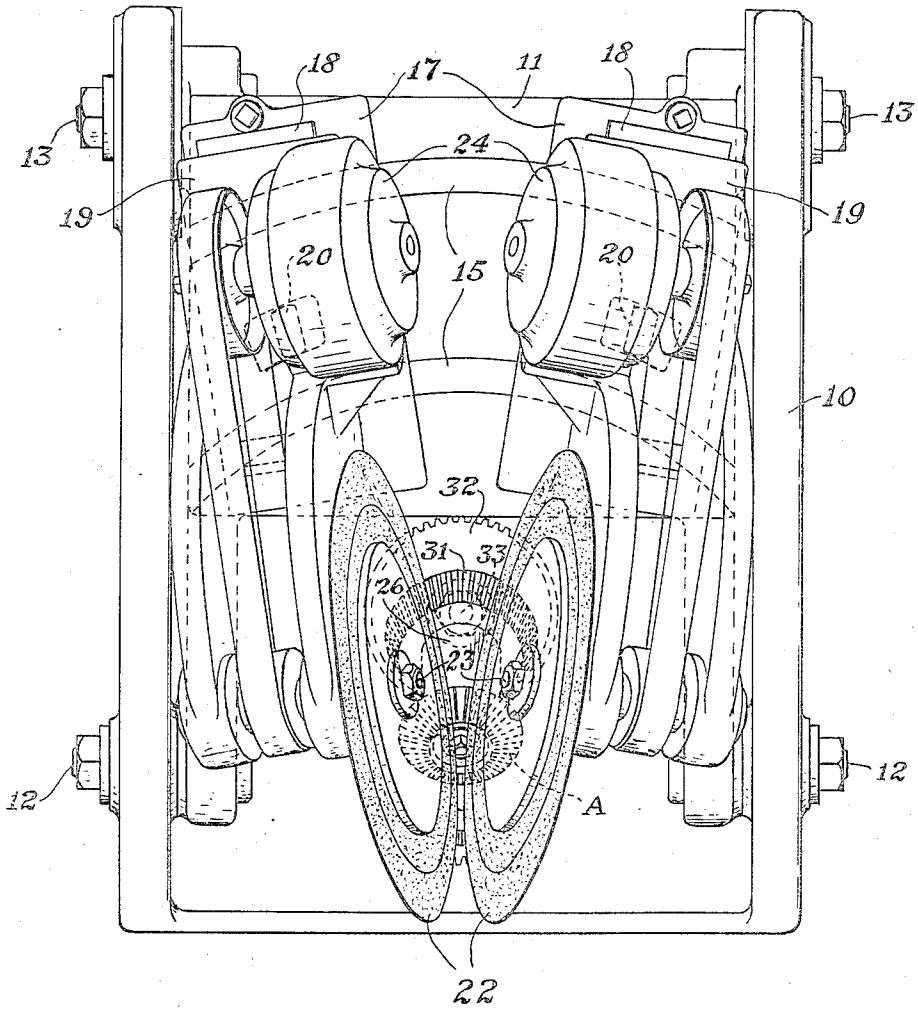
FIG. 3.



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UNITED STATES PATENT OFFICE.

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BEVEL-GEAR GRINDER.

Application filed July 31, 1924. Serial No. 729,270.

This invention relates to gear grinding machines and in particular to a machine for grinding the tooth curves of bevel gears, the machine being adapted to operate upon a tooth curve generating principle.

An object of the present invention is to provide a simple, durable and accurate machine for grinding the tooth curves of bevel gears upon a generating principle, and which may be used to rapidly complete the grinding operation upon all the teeth of bevel gears of widely different form and size.

One object which enables me to accomplish the above named object is that I provide a means for, in effect, rolling the gear blank being ground, the rolling path being similar to that which it would take if the bevel gear were being rolled upon a crown gear of conjugate form.

Another feature which is advantageous is that no special indexing means for the blank being ground is required for the reason that with each bodily movement of the blank about its path of movement, the gear is rotated to a point where different teeth are contacted by the wheel or wheels, that is, the blank is disposed at each revolution in successively different angular positions. Successive bodily movements of the gear about its path will therefore grind successively different teeth and, with the mechanism for effecting this rolling movement properly chosen, all of the teeth may be ground by continuing the revolution and rotation of the supporting member and the blank.

Another feature which is of advantage is that no reversals of movement of any parts of the mechanism supporting the blank take place during operation upon the blank being ground and therefore they may be moved at high speed thus increasing the production obtained from the machine.

With these and other objects in view, my invention consists in the features of construction and operation set forth in the following specification and illustrated in the accompanying drawings.

In the accompanying drawings annexed hereto and forming a part of this specification, I have shown my invention embodied in a machine particularly designed for bevel gears used in the differential of an automobile, but it will be understood that the invention can be adapted for a wide range of bevel gears and that the drawings are not to be construed as defining or limiting the scope of the invention, the claims appended to this specification being relied upon for that purpose.

In the drawings:

Figure 1 is a side elevation partly in section showing the operative portions of the machine.

Fig. 2 is a front elevation of the complete machine, parts being broken away to more clearly show their construction.

Fig. 3 is a plan view of the complete machine.

In the above mentioned drawings, I have shown but one embodiment of the invention which is now deemed preferable but it is to be understood that changes and modifications may be made within the scope of the appended claims without departing from the spirit of the invention.

Briefly, and in its broadest aspect, my invention comprises the following principal parts: a base having a frame mounted thereon which is adapted to be angularly adjustable about a fixed axis. On this frame are disposed angularly adjustable slides which carry wheel heads on which are rotatably mounted grinding wheels. Also on the base is a carrier or support for a bevel gear being ground which is rotatably mounted upon a shaft, the axis of which is fixed. Means are provided for rotating a shaft obliquely disposed in this carrier in timed relation to the revolution of the support, the blank to be ground being mounted upon one end of this shaft and the rotating means therefor on its opposite end. The combined movements of these parts is such that the blank being ground is rolled upon its pitch cone in a closed circular path as if it were being rolled upon a plane about the apex of its pitch cone. Also, by proper adjustment of the frame and carriages supporting the wheel together with the proper form of blank supporting member, the tooth flanks of a bevel gear of any apex angle may be ground.

Referring more in detail to the figures of the drawings, I provide a base 10 having mounted therein a frame 11 which may be oscillated about fixed trunnions 12 provided

on opposite sides of the base 10. This frame 11 may be securely clamped in any adjusted position by screws 13 passing through arcuate slots 14 provided in the frame 11. On the upper surface of the frame 11 are arcuate projections 15 adapted to enter corresponding grooves 16 in two independently adjustable carriages 17. The projections 15 and grooves 16 on the frame 11 and carriages 17 are so disposed that the carriages 17 may be angularly adjusted about a point intersecting the axis of the trunnions 12 about which the frame 11 is adjustable. By means of this construction, the carriages 17 may be angularly adjusted in any direction about the intersection of the axis of the trunnions 12 and the center of the arcuate slots 14, or in other words, they may be angularly adjusted in any direction about a common point forming the intersection of two axes.

These carriages 17 are each provided with parallel ways 18 adapted to be engaged by corresponding ways in the lower surface of a wheel head 19. The wheel heads 19, one of which is provided for each of the carriages 17, therefore may be moved back and forth or adjustably positioned along the ways 18 of the carriages 17 by means of a lever 20 oscillating about a short shaft 21 in the frame 11. Preferably one of these levers 21 is provided for each of the wheel heads 19 which may be operated in any preferred manner by suitable means, not shown. The wheel 22 on each wheel head 19 is adapted to be mounted upon a shaft 23 which may be rotated at high speed by means of a motor 24 directly mounted on the head 19. The wheels 22 also, as shown clearly in Figs. 1 and 2, engage the tooth surfaces of the gear blank A being ground upon their outside surfaces, these surfaces being substantially planes extending normally to the axis of rotation of each wheel rotating shaft 23 These work engaging surfaces of the wheels 22 may be dressed off accurately to predeter mined positions by any desired means (not shown) so that the blank engaging surfaces of the wheels 22 will be precisely plane and properly disposed angularly for any particular gear being ground. The mechanisms above described therefore enable the work engaging surfaces of the abrasive wheels 22 to be positioned at any angle to each other and at any angle relative to the axis about which the gear blank A is revolved. In this way, the wheels 22 may be adjusted to grind bevel gears of any apex angle and of any number of teeth.

In order to mount the blank A being ground in a manner permitting it to be bodily moved about in a circular or orbital path and simultaneously rotated upon its own axis, the following mechanism is provided: A rotatable shaft 25, which is vertically disposed in the preferred embodiment of the invention, is provided which is engaged by a blank supporting member 26 mounted thereon for rotation therewith. This supporting member 26 is provided with a hole extending obliquely to the axis of the vertical shaft 25, and through this hole extends a shaft 27 on which the gear blank A may be mounted adjacent one end.

The supporting member 26 for the blanks A must be of special form for bevel gears having different apex angles. This is for the reason that the position at which the gear blank A is mounted must be such that the teeth engaged by the wheels 22 will be disposed substantially in a plane including the axes about which the wheel carrying members 11 and 17 are adjustable. In each supporting member 26, the blank carrying shaft 27 is disposed precisely at a predetermined oblique angle suitable for bevel gears of but one apex angle. The vertical shaft 25 is directly keyed or otherwise secured to the supporting member 26 so that this member and vertical shaft rotate together and at the same speed. Rotatably surrounding a portion of the supporting member 26 is a gear member 28 having spur and bevel gears 29 and 30 thereon. The bevel gear 29 is adapted to engage a bevel gear 31 on the lower end of the blank carrying shaft 27 and the spur gear 30 engages a corresponding spur gear 32 on a main driving shaft 33. The vertical shaft 25 carrying the supporting member 26 may be rotated from any suitable source through a spur gear 34 thereon, this gear, in the form of the invention illustrated, being in mesh with a gear 35 on the main driving shaft 33.

It will be understood that for bevel gears of different form and numbers of teeth, the ratio between the rotations of the supporting member 26 and the blank A must be varied. For this reason, the gear member 28 is adapted to be readily changed so that others may be substituted to rotate the supporting member 26 and the blank carrying shaft 27 at the correct relative speeds. Also the gear 32 on the main driving shaft 33 may be changed to mesh with the spur gear 30 of different diameter on the supporting member 26.

The axis of the shaft 25 mounting the blank supporting member 26 intersects the axis of the fixed trunnions 12 at the same point as the center of the arcuate projections 15 on the wheel carrying frame 11. Also the supporting member 26 for the blank A is selected so that the blank A is held with the apex of its pitch cone coinciding with the intersection of the axes of the vertical shaft 25 and trunnions 12.

With the blank A in position for grinding on the supporting member 26, the uppermost elements of its pitch cone extend in a direction normal to the axis of the vertical shaft

25 and, as the supporting member 26 and shaft 27 rotate, successive elements of the pitch cone sweep out a plane. It is the teeth standing uppermost on the blank A in position to be in engagement with an intersecting conjugate crown gear that are engaged and ground by the wheels 22 at each rotation of the supporting member 26.

From the above described construction, it will be seen that rotation of the main driving shaft 33 will rotate the vertical shaft 25 at a relatively low speed through gears 34 and 35 and will also revolve the bevel gear blank A mounted on the supporting member 26 about the apex of its pitch cone. Also the blank A will be rotated about its own axis at a suitable speed through the bevel gears 29 and 31 as shown in Fig. 1. The resultant movement of the gear blank A is therefore a bodily movement about the vertical shaft 25, the axis of which intersects the apex of the pitch cone of the gear blank A, the shaft 27 carrying it being revolved so that it sweeps out a conical surface. This cone swept out by the shaft 27 is disposed so that it supports its gear blank A with the upper element of its pitch cone exactly normal to the vertical shaft 25. The path of movement therefore of the upper portions of the blank A is circular and about a plane surface. In all cases, the oblique shaft 27 carrying the blank A being ground is disposed at the correct angle to properly support the blank A in exactly this manner.

Simultaneously with this bodily movement of the blank A, it is rotated by means of the gearing above described so that with properly selected gearing the combined resultant movement of the gear blank is a rolling movement of its pitch cone circularly about a plane. The movement of the gear blank A in effect is therefore a rolling movement upon a conjugate crown gear placed to properly intermesh with the gear blank as it is bodily moved about it. It will be seen therefore that by means of the shaft 27 and the means for rotating the supporting member 26, the gear blank A may be given this combined revolving and rotating movement at high speed for the reason that there are no reversals of direction of movement and all parts move continuously at the same constant speed.

If the bevel gear blank A should complete exactly an integer number of rotations during each of its revolving movements, the same teeth on the blank A would be presented to the wheels 22 at each revolution. I therefore choose the gearing for rotating and revolving the blank in such manner that the rotative movement is not an aliquot or commensurate part of the revolving movement. Each revolving movement therefore of the supporting member 26 will cause the gear blank A to be presented to the wheels 22 in angularly different positions. Properly selecting the gearing for the supporting member 26 and the gear rotating shaft 27 enables the gear blank A to be indexed one or more tooth spaces with each revolution of the supporting member.

During the combined revolving and rotative movements of the blank A, the wheel heads 19 may be slowly advanced toward the apex of the pitch cone of the blank A so that the gear teeth will be ground over their entire length. This movement of the wheels 22 may take place simultaneously, or, first one wheel 22 may be advanced and then the other in accordance with the movements imparted to the levers 20. For narrow faced bevel gears, no reciprocatory movement of the wheels 22 may be required or necessary, and, after the wheels 22 are adjusted to their proper positions for grinding opposite sides of the teeth on the particular gear being ground, they may be clamped in position. With the wheels 22 so adjusted, the entire surface of the tooth curves may be ground while the revolving motion of the blank continues.

What I claim is:

1. A bevel gear grinder comprising in combination, a base, a support thereon, a wheel adjustable on said support, means to rotatably support a blank to be ground, means to revolve said blank bodily in an orbital path, and means to simultaneously rotate said blank upon its axis, the rotary and revolving movements being incommensurate with each other whereby the blank will be angularly advanced at the completion of each revolving movement.

2. A bevel gear grinder comprising in combination, a base, an abrasive wheel adjustably supported thereon, a gear blank supporting member adapted to rotatably support a gear blank, means to rotate said blank about its axis, and means to simultaneously rotate said blank about an axis oblique thereto whereby a rolling motion of the blank upon its pitch cone is simulated, said rotative movements being incommensurate with each other so that the blank is angularly advanced at the completion of each revolving movement.

3. A bevel gear grinder comprising in combination, a base, a support thereon, an abrasive wheel on said support, means to adjust the position of said wheel angularly in any direction about a point, and means to continuously roll a bevel gear blank about said point past a work engaging surface of said wheel.

4. A bevel gear grinder comprising in combination, a base, a support thereon, means permitting adjustment of the position of said support in one direction, a carriage on said support adjustable in another direction, a wheel adjustably mounted on said

carriage, and means to continuously roll a bevel gear blank upon its pitch cone past said wheel.

5. A bevel gear grinder comprising in combination, a base, a support thereon, means permitting adjustment of the position of said support in one direction, a carriage on said support adjustable in another direction, a head on said carriage, a wheel rotatably mounted on said head, means to adjust the position of said head and wheel on said carriage, and means to continuously roll a bevel gear blank upon its pitch cone past said wheel.

6. A bevel gear grinder comprising in combination, a base, a support thereon, means permitting adjustment of the position of said support about an axis, a carriage on said support adjustable about an axis intersecting the axis about which the support is adjustable, a head on said carriage, a wheel rotatably mounted on said head, means to adjust the position of said head and wheel on said carriage, and means to continuously roll a bevel gear blank upon its pitch cone past said wheel.

7. A bevel gear grinder comprising in combination, a base, a support thereon, an abrasive wheel on said support, means to adjust the position of said wheel angularly in any direction from a point, means to reciprocate said wheel toward and from said point, and means to continuously roll a bevel gear blank about said point past a work engaging surface of said wheel.

8. A bevel gear grinder comprising in combination, a base, a support thereon, means permitting adjustment of the position of said support about an axis, a carriage on said support adjustable about an axis intersecting the axis about which the support is adjustable, a head on said carriage, a wheel rotatably mounted on said head, means to reciprocate the head toward and from the point of intersection of said axes, and means to roll a bevel gear blank about said point past a work engaging surface of said wheel.

9. A bevel gear grinder comprising in combination, a base, a support thereon, a pair of abrasive wheels on said support, means to adjust the position of said wheels angularly in any direction from a point, independent means to reciprocate said wheels toward and from said point, and means to roll a bevel gear blank about said point past a work engaging surface of said wheel.

10. A bevel gear grinder comprising in combination, a base, a support thereon, means permitting adjustment of the position of said support about an axis, carriages on said support adjustable about an axis intersecting the axis about which the support is adjustable, heads on each of said carriages, wheels rotatably mounted on said heads, independent means to reciprocate each head toward and from the point of intersection of said axes, and means to roll a bevel gear blank about said point past a work engaging surface of said wheels.

In testimony whereof, I hereto affix my signature.

S. JAY TELLER.