Oct. 3, 1939. E. L. ACKERMAN 2,174,814

METHOD OF FORMING HELICAL GEARS

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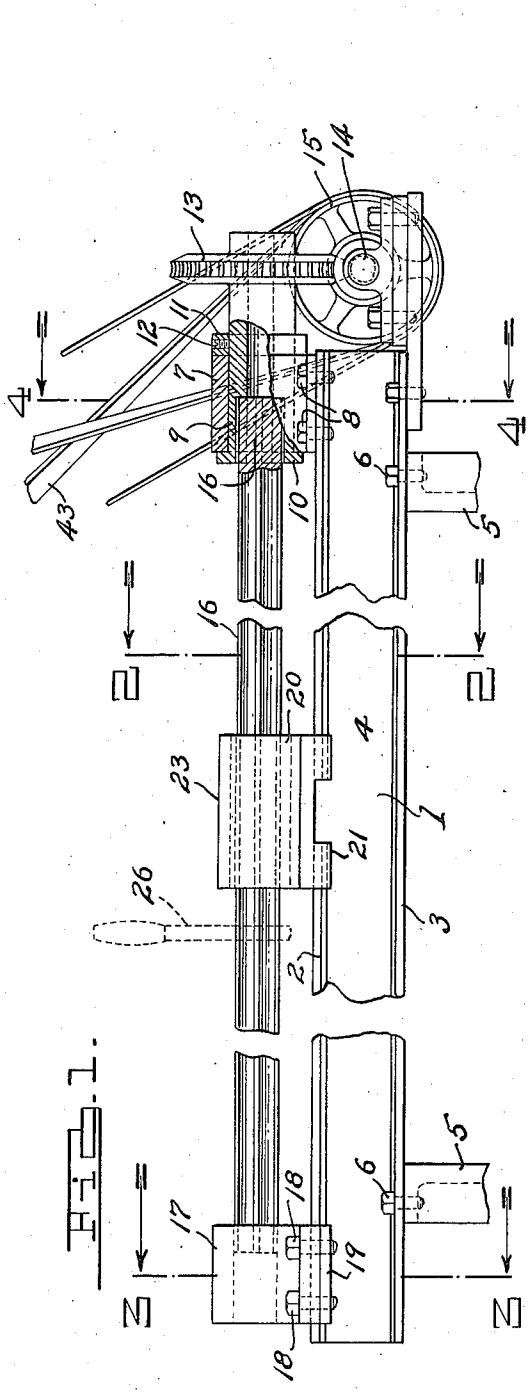


Fig. 1.

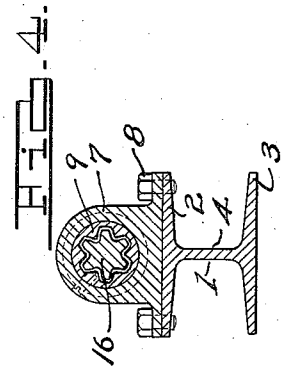


Fig. 4.

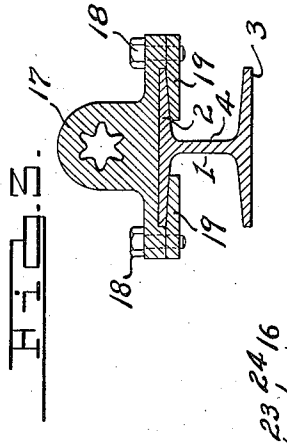


Fig. 3.

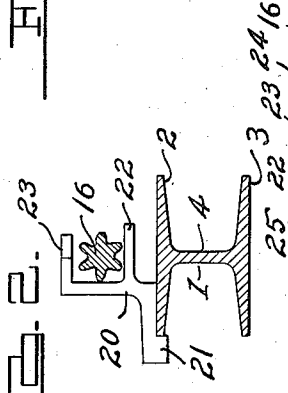


Fig. 2.

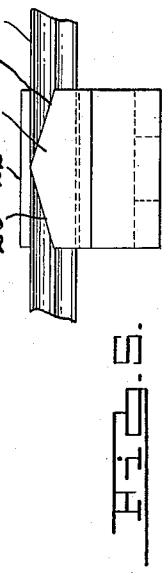


Fig. 5.

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Fig. 6.

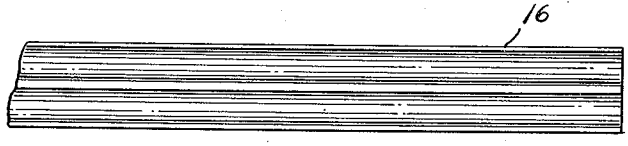


Fig. 7.

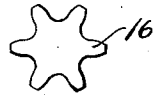


Fig. 8.

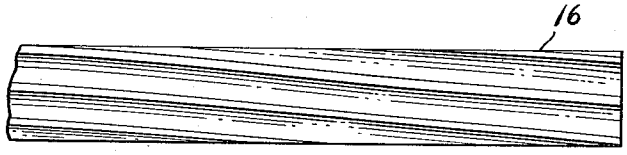


Fig. 9.

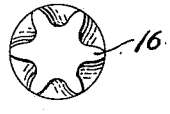


Fig. 10.

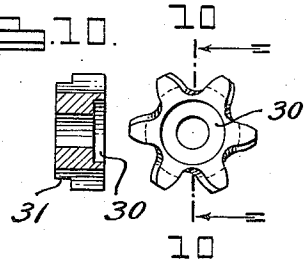


Fig. 12.

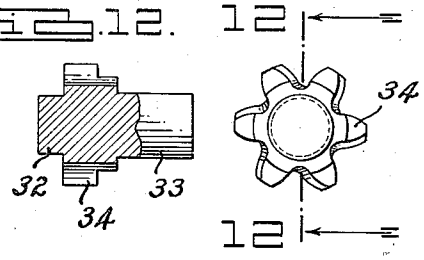


Fig. 11.

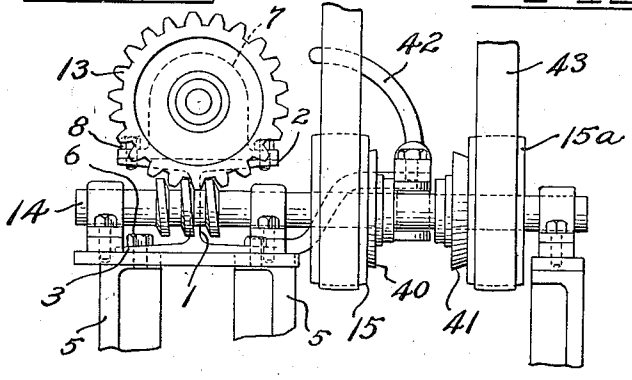


Fig. 13.

Fig. 1A.

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UNITED STATES PATENT OFFICE

2,174,814

METHOD OF FORMING HELICAL GEARS

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Application March 31, 1937, Serial No. 134,117

3 Claims. (Cl. 29—159.2)

This invention relates to a method of making helical gears, and the object of the invention is to provide a method and means for performing the same which involves the twisting of pinion rod stock in long lengths to thereby twist the teeth of the pinion rod to form uniform spiral teeth longitudinally thereof during which operation the rod is held at its ends in a manner to prevent shortening of the rod and thereby producing a longitudinal strain in the rod.

Pinion rod stock which is provided with the teeth extending longitudinally thereof and is about eleven feet in length is not uniform in hardness—that is, it has hard and soft spots which will tend to prevent the metal twisting as readily at the hard spot as it will in a preceding or succeeding soft portion but, by placing the rod under longitudinal strain sufficient to prevent material shortening of the rod due to the twisting, the twisting strain is distributed practically uniformly from end to end of the rod thereby forming the teeth in a true helix.

The method further involves the cutting of the rod in a manner to provide helical gears of the desired width of face and form of hub as is hereinafter more specifically set forth.

Heretofore, helical gears have been formed by gear cutting machines which is a somewhat expensive process and the purpose of this invention is to provide a method by which true helical gears may be formed at a minimum of expense and avoiding the cutting and handling costs.

These and other objects and various novel features of the invention are hereinafter more fully described and claimed, and the preferred method and means for performing the same is shown in the accompanying drawings in which—

Fig. 1 is a side elevation of a machine constructed and adapted for use in the twisting of the rod, a gauge being provided that is movable along the twisted rod to determine the extent to which the rod requires to be twisted to form the teeth on a predetermined helical angle.

Fig. 1ª is an elevation of the machine taken from the right hand side of Fig. 1.

Fig. 2 is a section taken on line 2—2 of Fig. 1.

Fig. 3 is a section taken on line 3—3 of Fig. 1.

Fig. 4 is a section taken on line 4—4 of Fig. 1.

Fig. 5 is an enlarged plan view of the gauge.

Fig. 6 is a side elevation of ordinary commercial pinion rod stock.

Fig. 7 is an end view thereof.

Fig. 8 is a side view of the rod after having been twisted.

Fig. 9 is an end view thereof.

Fig. 10 is a section through a formed helical gear taken on line 10—10 of Fig. 11.

Fig. 11 is an end elevation thereof.

Fig. 12 is a sectional view of another form of helical gear taken on line 12—12 of Fig. 13.

Fig. 13 is an end elevation of the formed gear.

In Fig. 1 is shown a convenient form of machine for the twisting of a pinion rod. This machine consists of a frame member 1 which may be of the common form of steel beam having top and bottom flanges 2 and 3 and a central web 4 therebetween. The bottom flange provides a means for attaching to leg portions 5 as by means of the bolts 6 extending through the bottom flange 3 as shown in Fig. 1. On the top flange 2 at one end is secured a head 7 also by means of bolts 8 extending through a flange of the head into the upper flange 2 of the beam. Rotatably supported in this head is a rod holder 9 flanged as at 10 at its forward end to engage over the inner face of the head 7 and provided with a collar 11 secured to the body of the holder as by means of a screw 12 to engage the outer face of the head and prevent longitudinal movement of the holder in the head. The outer end of the rod holder, in the structure shown, has a worm wheel 13 secured thereto which meshes with a worm 14 on the shaft that is driven by a pulley 15. As shown in Fig. 1ª, there is a second pulley 15ª on the shaft 14 and both pulleys are loose on the shaft and between the same is a clutch having two cone faces 40 and 41 shiftable by a lever 42 to clutch one or the other of the pulleys 15 or 15ª to the shaft. The rod holder 9 is internally toothed as will be understood from Fig. 4 and fits the end of the pinion shown in the same manner as internal and external gears mesh, there being sufficient clearance provided to permit ready insertion of the end of the pinion shaft 16 longitudinally thereinto.

The pinion shaft is a commonly known article of commerce and may be obtained in lengths of about eleven feet but in so far as this invention is concerned, the length of the pinion shaft is not material. At the end of the beam 1 opposite the head is a tail stock 17 which is formed to provide internal gear teeth corresponding to the internal gear of the rod holder 9 and receives an end of the pinion rod which extends thereinto in the neighborhood of an inch as will be understood from Fig. 1. The tail stock is provided with bolts 18 which extend into clamp elements 19

spaced from the base of the part 17 to provide ways for the upper flanges 2 of the beam. This permits the tail stock to be moved longitudinally of the upper flange to properly position the same for different lengths of rod. Also slidably mounted on the upper face of the top flange 2, is a gauge 20 having a base 21 of considerable width to normally sustain the gauge in an upright position on the beam and having an inwardly extending lower flange 22 and an upper flange 23, the forward edge of which is formed with oppositely inclined faces 24 and 25 as will be understood from Fig. 5. The pinion shaft or rod 16 is supported at its ends and lies in the recess between the lower and upper flanges 22 and 23 and the inclined faces of the upper flange are formed at the helical angle to which the teeth are to be formed and provide a visible means of determining the uniformity of the twist at any points of the shaft by simply sliding the same along under the eye of the operator. One face 24 is used to gauge a right hand spiral and the other a left hand spiral either of which may be formed by reversing the direction of rotation of the rod.

Bearing in mind that pinion rod stock has hard and soft spots, there may be a portion or several portions of greater hardness than intervening portions which may not twist as readily as the softer portions thus tending to distort the helical line passing from the soft spot through the hard spot or vice versa. The operator, as the rod is being twisted, may discover such slight distortions by using the gauge and, by means of a wrench of the proper form which is merely indicated by dotted lines 26 in Fig. 1, the shaft may be turned at that spot by manually applying strain to assist the twisting or to retard it to maintain the twist of the shaft to form the teeth in a uniform helix from end to end.

The twisting of the shaft is produced by the gear train heretofore mentioned which is operated by power and may be provided with a means for stopping or starting the twisting movement as, for instance, by a shifting of the belt on the pulley 15 to an idle pulley or from the idle pulley to the pulley 15. With the power applied to the pulley 15, the shaft is held stationary in the tail stock and is rotated in the head stock the desired number of turns to form the teeth on the desired helical angle. The twisting is comparatively slow due to the speed reducing gear train and thus by the sliding of the gauge along the rod as the twisting progresses, the operator can at all times readily note the progress of the work or spots where the twist is retarded or accelerated as by too hard or too soft spots in the metal and can stop and start the machine as may be required while trueing a portion of the rod by means of the wrench device 26 as heretofore described.

It will be noted that the rod in the machine shown is not fastened in either the head or the tail stock. This is the preferable method and the rod extends into the head and tail stock a sufficient distance to insure sufficient surfaces in pressure contact under the power applied in twisting to prevent material slippage—that is, to insure tension being applied to the rod during the twisting. Without some means being provided to place longitudinal tension on the rod, it will not, although twisted, be uniformly twisted and even with the ends of the rod being held from movement in the head and tail stock there still are portions of such hardness or softness as to require manual application to either assist or retard the twisting at such spot.

The rod, as shown in Fig. 6, is the usual pinion rod and Figs. 8 and 9 show the twisted rod having the teeth of the pinion rod formed on a helical angle in the manner hereinbefore described. The twisted rod is introduced into an automatic machine of the type now in use with the rod stock of Figs. 6 and 7 and sections are formed and cut off from the end of the rod which feeds into the cutter as each part is formed. There are two gear forms shown in Figs. 10 to 13 inclusive. In Figs. 10 and 11, the gear is formed with a recess 30 in one face and the teeth are cut back as at 31 which is required for certain use of such a gear or the gear may be formed as shown in Fig. 12 with a pilot 32 at one end and an extending shaft 33 at the other side, the teeth 34 being substantially the same as in Fig. 10.

I have not described the special machines (which are of the screw machine type) that may be utilized in the cutting of the gears as such machines are well known. In forming a gear having the pilot 32 and the shaft portion 33 of Fig. 12, the twisted stock is cut to below the roots of the teeth to provide the intermediate section having the teeth 34 each of which will be on the true helical angle and practically as perfect as have been produced by previous known methods. Other gear forms may likewise be readily made with side faces of the desired shape either with or without hubs. In the cutting of a gear in a gear cutting machine the stock used is approximately the total length of the final gear and requires handling in positioning the machine for cutting the teeth and in other machines for forming the pilot and shaft portions or in the case of the form shown in Fig. 1, after the gears are cut, the gear is bored and counter-bored, in all of which previous operations there is time and labor loss due to the necessity of introducing the small parts into the machine and removing therefrom, etc. In my improved method, I avoid excessive costs in the cutting and in the formation of the final gear due to the fact that the teeth are formed on a helix by a mere twisting of a rod of a length materially greater than the width of the gears to be cut therefrom to provide a large number of gears. The twisted rod is then fed into an automatic machine having cutters which work upon the rod end and each is formed for cutting from the twisted rod and the rod then moved forward to position the end thereof for a succeeding operation.

Thus, in the formation of small helical pinions, for instance, the labor cost is very materially reduced in that once a rod is placed in the automatic machine, it is continuously fed thereinto as the gears are formed and cut from the end thereof without necessity of manipulation by an operator—that is, if the rod is ten feet long and the gears were an inch long, the positioning of one rod in the machine would be the only hand operation required for in the neighborhood of one hundred and twenty gears. This, of course, would vary with the width between the side faces of the gear including the pilot or shaft portion.

By the above described method, a helical gear of considerable length may be provided. Due to the twisted rod having the teeth formed on a true and uniform helix, the helical gear can be used in mesh with the original pinion rod having the spur type of teeth when the twisted rod has its axis lying at the helical angle to the axis of the spur gear. There will, of course, be some friction

if the gears are held from longitudinal displacement but in many cases, especially where there is not a rapid rotation of the gears as in many machines, the friction is negligible. Therefore, my improved method is not confined to the formation of gears of short face widths or to the shapes of gears shown in Figs. 10 and 12.

In the machine shown, the pulley 15[a] is driven by a cross belt 43 which enables the shaft 14 to be turned in an opposite direction from that by which it is driven by the pulley 15. The rod holder 9, due to its worm and a worm gear drive, cannot unwind to release the pinion shaft from frictional engagement in the head and tail stocks and the above described arrangement permits reversely rotating the head stock to release the torsional strain on the pinion shaft, and the arrangement may be used to make right or left hand helical gears.

From the foregoing description, it is believed evident that the various objects and features of the invention are attained by the structure described; that the method provides for rapid manufacture of helical gears at materially less cost than the usual cut gears of the helical type due to the comparatively low cost of the pinion rod which is of standard manufacturing and is made in large quantity not being much more expensive than solid rod.

Having thus fully described my invention, its utility and mode of operation, what I claim and desire to secure by Letters Patent of the United States is:

1. The method of forming a helical gear which consists first in the formation of radial teeth of the required form in cross section to provide a tooth of the desired type, said teeth being formed the full length of a long rod and in parallel relation, twisting the rod about its longitudinal axis by application of force at one end of the rod while under longitudinal tension to thereby form the teeth of a uniform helical angle from one end to the other of the rod, then cutting the rod to form blanks of a length equal to the desired width of gear face and length of hub, and finally cutting the blanks for a distance from one end to provide the desired width of gear face and form of hub.

2. The method of forming a helical gear which consists first in the formation of radial teeth of the required form in cross section to provide a tooth of the desired type, said teeth being formed the full length of a long rod and in parallel relation, twisting the rod about its longitudinal axis by application of force at one end of the rod while under longitudinal tension to thereby form the teeth of a uniform helical angle from one end to the other of the rod, then cutting the rod to form blanks of a length equal to the combined width of gear face and length of hub, and finally cutting the blanks at each end to provide a gear with a hub of the desired length at each side thereof.

3. The method of forming helical gears which consists in forming teeth on a comparatively long length of substantially round rod longitudinally of the rod in parallel relation, submitting the toothed rod to longitudinal tension, then twisting the rod about its longitudinal axis by application of twisting force to one end while the opposite end is held from rotative movement while permitting movement of the said end longitudinally to thereby twist the rod to form the teeth at the desired helical angle, retarding or accelerating the formation of the twist at points along the length of the rod to compensate for variation in hardness and/or density of the metal, and then cutting successive portions of the rod from one end thereof to provide a gear of the desired face width.

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