March 9, 1926.

1,575,713

C. G. OLSON

GRINDING MACHINE

Filed August 1, 1923 4 Sheets-Sheet 1

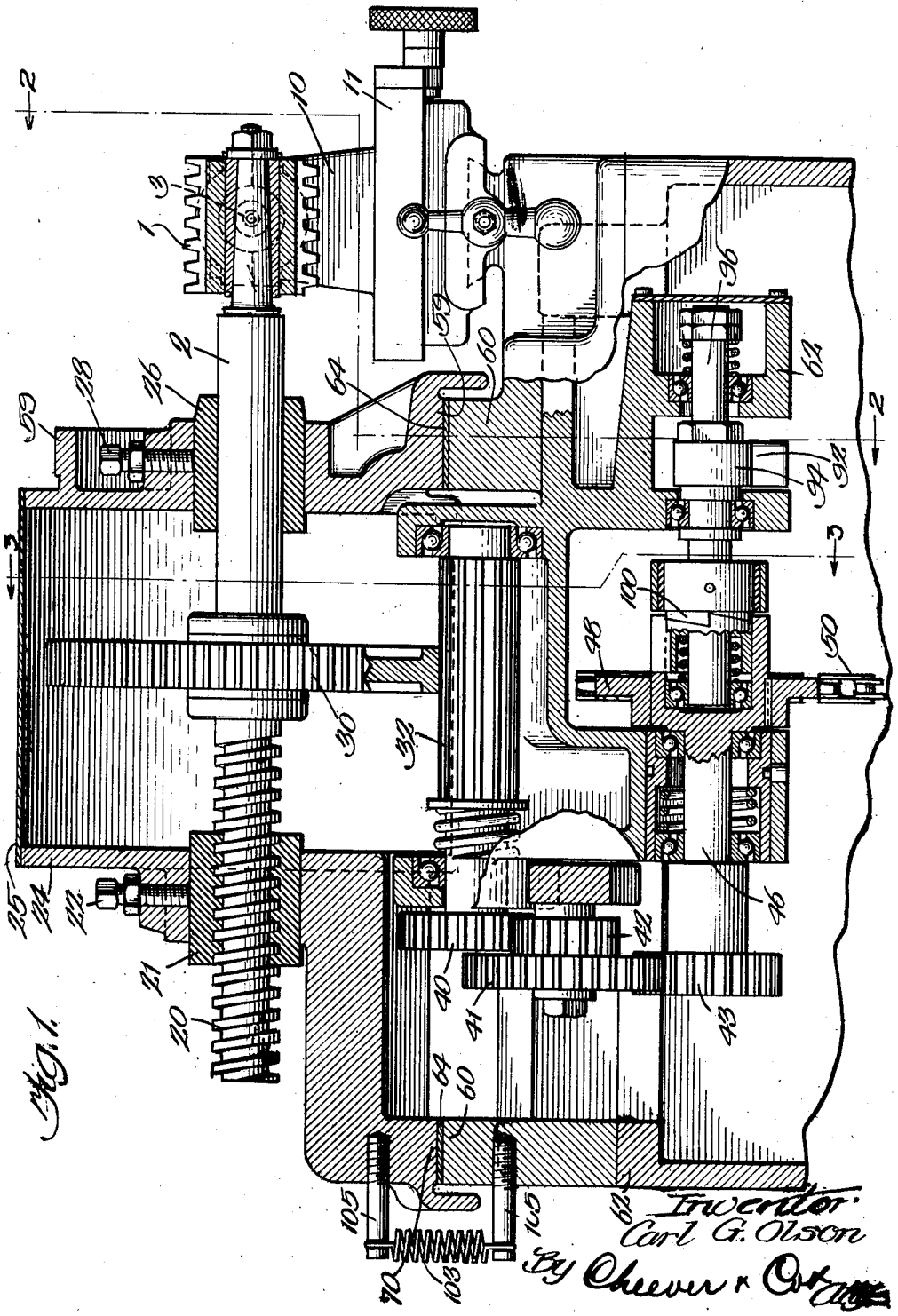

Fig. 1.

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GRINDING MACHINE

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Fig. 2.

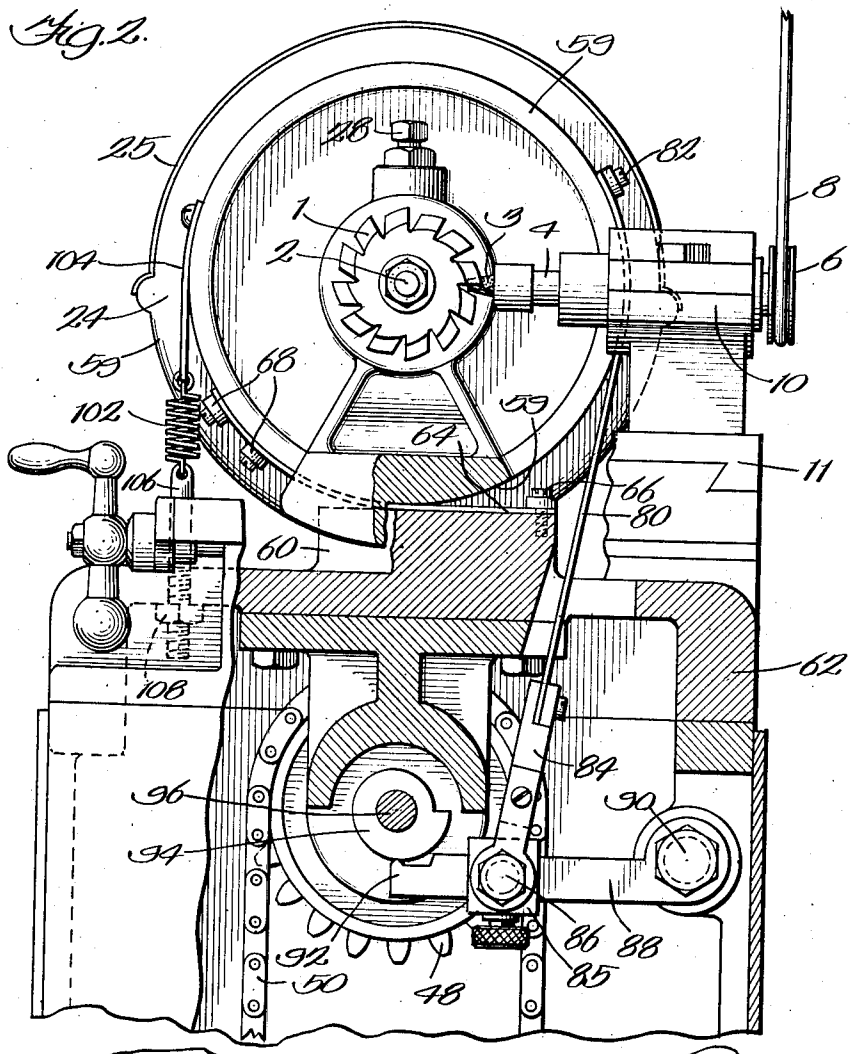


Fig. 9.

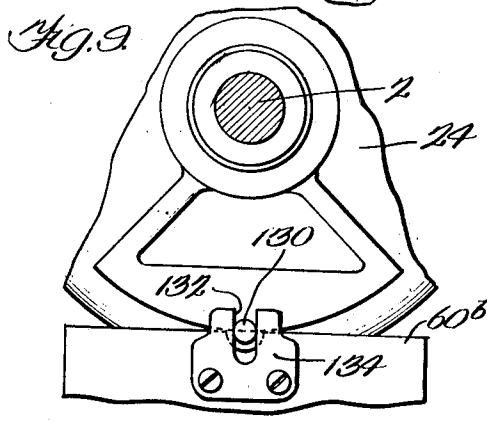
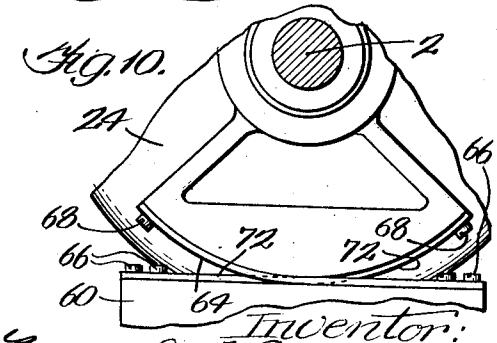


Fig. 10.



Inventor:
Carl G. Olson
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March 9, 1926. 1,575,713

C. G. OLSON

GRINDING MACHINE

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Fig. 3.

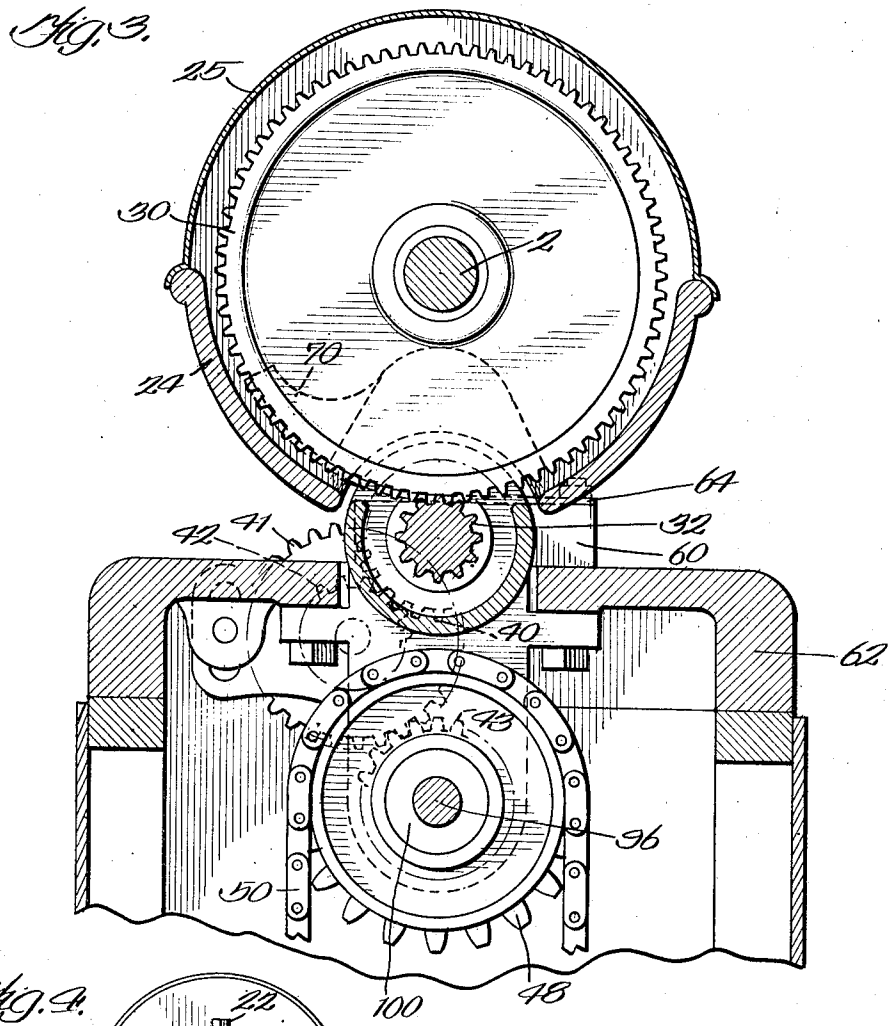
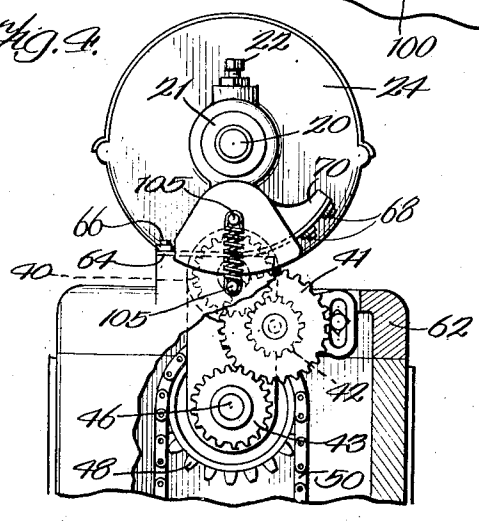


Fig. 4.



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March 9, 1926.

1,575,713

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GRINDING MACHINE

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Fig. 5.

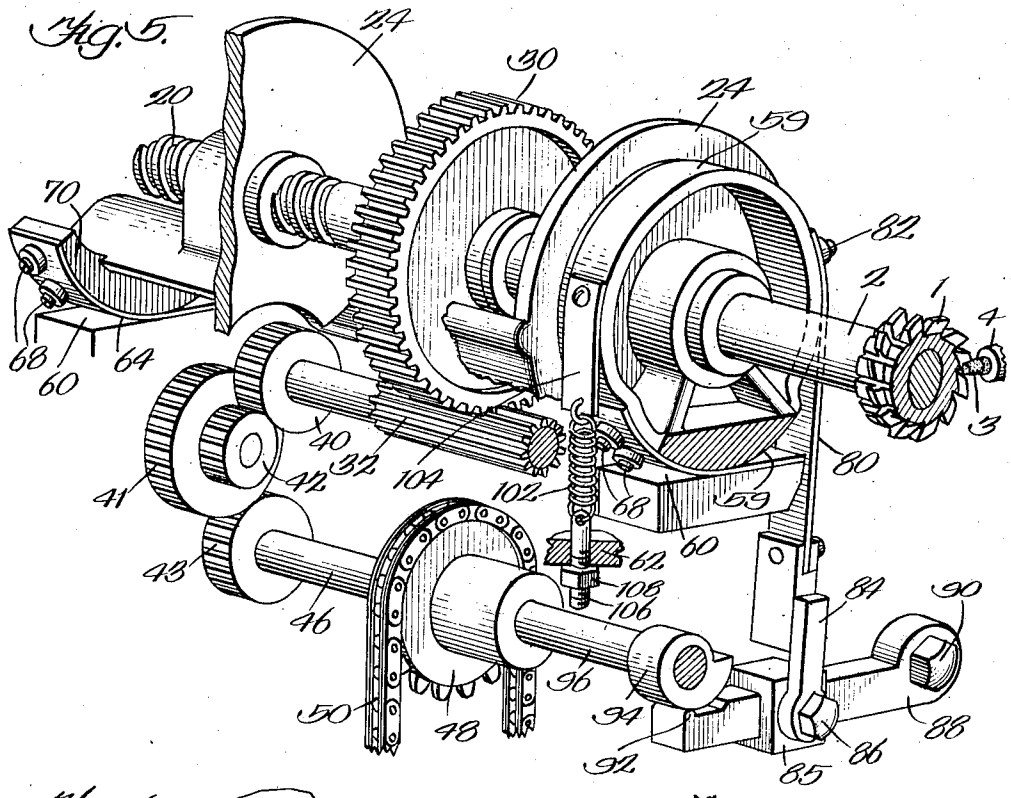


Fig. 6.

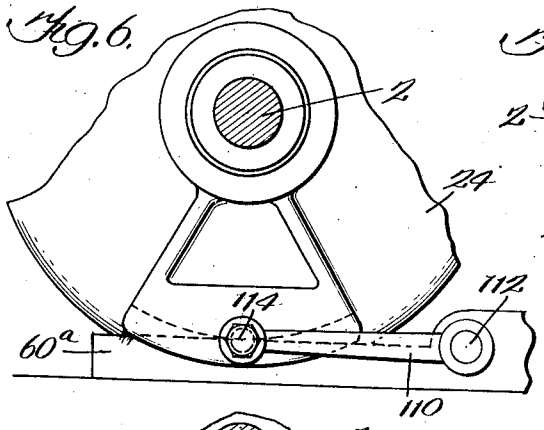


Fig. 7.

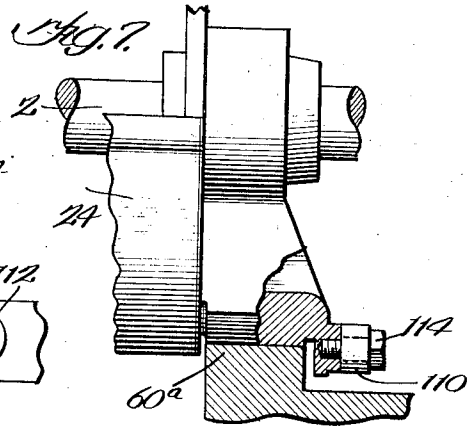
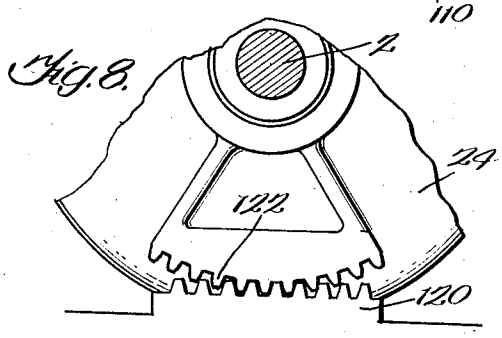


Fig. 8.



Inventor:
Carl G. Olson.
By Cheever & Cox
Attys

Patented Mar. 9, 1926. 1,575,713

UNITED STATES PATENT OFFICE.

CARL G. OLSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO ILLINOIS TOOL WORKS, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

GRINDING MACHINE.

Application filed August 1, 1923. Serial No. 655,016.

To all whom it may concern:

Be it known that I, CARL G. OLSON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Grinding Machines, of which the following is a specification.

My invention relates to grinding machines, and is especially useful for grinding articles having relieved teeth such, for example, as hobs. In relieving the teeth of cylindrical cutters, of which hobs are an example, there is a relative movement of the tool and the work toward and away from each other while the cutter is being rotated. This relative movement is usually accomplished by having the tool unit and the work unit of the machine slidably connected and actuated by a cam which is geared to rotate in timed relation to the work. An example of such machine is a backing-off lathe, which has been well known for many years. The relative movement of the work and the tool in some of the more recent grinding machines is effected by having either the tool unit or the work unit of the machine swing on pivots. The former construction is shown in my Patent No. 1,259,770 granted March 19th, 1918, and the latter construction is shown in the patent issued to me and F. W. England July 5th, 1921, No. 1,383,843.

The grinding of the teeth of hobs is an operation of such refined precision that the slightest wear in the operating mechanism of the grinding machine may cause the cutting edges of the hob teeth to vary from the true helix, and when this occurs even to a fraction of one one-thousandth of an inch the hob will not produce good gears.

The machines in which the tool holder or the work holder oscillated about a pivot to produce the relief, were an improvement over the machines of the sliding type but had the disadvantage that the movement was not strictly rectilinear (radial) and the object of my present invention is to produce a machine in which the movement will, within the ordinary limits of operation, be substantially in a straight line, and radial with respect to the hob cutter or other piece of work in hand.

Another object of the invention is to produce a machine of simplified construction, especially with respect to the parts which cause this radial movement, and also to produce a machine in which the wear and the effects of wear will be reduced to a minimum.

Generally speaking, one of the two elements (the work holder or the tool holder) is mounted in an element which is adapted to roll back and forth upon a track to effect the radial movement necessary for producing the relief in the teeth of the work. According to the illustrated form it is the work holder which rolls back and forth toward and from the grinding tool. In the illustrated case, in which the work is a hob, means are provided for feeding the work spindle axially in accordance with the helix or lead of the hob teeth.

I obtain my objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is an elevation of the machine, chiefly in axial section.

Figure 2 is a sectional elevation on the line 2—2 Fig. 1.

Figure 3 is a sectional elevation on the line 3—3 Fig. 1.

Figure 4 is an end elevation looking towards the right in Figure 1. In this view certain parts are broken away to better reveal the internal construction.

Figure 5 is a perspective view showing the chief operating parts, especially those more intimately connected with my present invention.

Figure 6 is a detail showing a modified manner of holding the rolling element upon the track. The view is an end elevation.

Figure 7 is a side elevation partly in section of the parts shown in Figure 6.

Figures 8 and 9 are similar to Figure 6 but show still other modifications of the mechanism for holding the rolling element upon the track.

Figure 10 is a fragmentary perspective view of a modified form of connection between the rolling work holder and the tracks on which it rolls.

Like numerals refer to like parts throughout the several views.

In the illustrated form of the invention the work consists of a hob 1, which is rigidly secured to a work spindle 2. This spindle

imparts three different kinds of movement to the hob—a rotary movement, an axial movement to accord with the lead of the hob helix, and a radial movement toward and from the grinder 3.

In the present case the grinder is a formed grinding point which is secured to a grinder spindle 4, rotated at high speed by any suitable mechanism, for example, a pulley 6 and belt 8 shown in Figure 2. The grinder rotates in place during any single pass and is mounted in a tool post 10 rising from a carriage 11. This carriage is capable of the usual adjustments and as it is not intimately concerned with the novelty of my present invention, need not be described in detail. A tool carriage suitable for the purpose is described in detail in the copending application of Charles J. Irwin, for hob grinder, filed May 3, 1923, Serial No. 636,323.

The work spindle 2 has a threaded portion 20 which has a helix angle corresponding to the helix angle of the hob teeth. It works in a nut 21 secured by a set screw 22 or other appropriate means in a rolling element 24 which will be hereinafter described. The spindle has a supplemental bearing in a sleeve 26 which is secured in said rolling element by means of a set screw 28 or other suitable mechanism.

The work spindle is driven by means of a gear 30 which is rigidly fastened to it and meshes with a wide-faced pinion 32. The means for supporting and driving this pinion may be considerably varied and need not be described further than to say that the pinion has a stationary axis and is driven by a train of gears 40, 41, 42, 43. Gear 43 is fastened to a power shaft 46 which has a stationary axis, and is driven in any suitable manner, for example, a sprocket wheel 48 and chain 50. In practice the latter is usually driven by an electric motor (not shown).

With the exception of the rolling element 24 the parts thus far described are not herein claimed as new. Referring now to said rolling element and the parts which relate more intimately to the essence of the invention:

In the form illustrated the rolling element, which is represented in general by the numeral 24 and may be regarded as the rolling work holder, is in the general form of a housing which encloses the gear 30. It has a cylindrical cover 25. It has rigidly connected to it two cylindrical treads 59 which are supported by tracks 60 secured to the framework 64 of the machine. These tracks are parallel to each other and extend crosswise to the axis of the work. In the form shown in Figures 1 to 4 of the drawing the rolling work holder does not rest directly upon the tracks but upon steel tapes or bands 64. One end of these tapes is fastened by screws 66 to the surface of the track and the other end by screws 68 to the tread 59. These bands are of considerable width and are rigidly fastened to the respective parts. The result is that they effectually prevent movement of the rolling element in an axial direction. They also prevent slippage, angularly, of the treads relatively to the tracks. As a special precaution against axial and angular slippage the expedient shown in Figure 10 may be employed, in which case there is an additional band 72 connecting the parts but arranged oppositely. The treads are of considerable diameter compared with the diameter of the hob, and it will be evident that when the work holder rolls back and forth on the tracks within the slight range called for by the relief or eccentricity of the hob teeth the movement of the hob toward and from the grinder will, to all intents and purposes, be in a straight line radial to the hob.

Now considering the mechanism for causing the work holder to roll back and forth upon the tracks:

A steel band or tape 80 is fastened at one end by a screw 82 to one of the treads of the rolling element and at the other end is connected by a link 84 and pivot pin 86 to a block 85 which is adjustable lengthwise on an arm 88 having a stationary pivot 90, as best shown in Figures 2 and 5. The free end of this arm has a nose 92 which engages the acting surface of a cam 94 fastened to a cam shaft 96. This shaft is journaled in suitable bearings in the framework 62 of the machine as shown in the lower portion of Figure 1. According to the preferred design this shaft is in line with the power shaft 46 previously mentioned and is connected thereto through the agency of a toothed clutch 100. This clutch makes one-way engagement so that when the power shaft is rotating in the forward direction it will rotate the cam but when it is rotating in the reverse direction to shift the work spindle 2 back to initial position, axially, the cam will not be rotated.

The band or strap 80 operates chiefly in tension and in a direction to move the work toward the grinder. The return movement or backing off is accomplished by means of a tension spring 102 shown in Figures 2 and 5. This spring is connected at one end to the tread 59 by a strap 104 and at the other end is connected by a threaded adjusting rod 106 and nut 108 to a portion of the framework 62. Thus the strap 80 pulls the work holder forward and the spring 102 pulls it back when the tension of strap 80 is released. The spring also has the effect of keeping the nose of the arm 88 in close contact with the cam, and of keeping the workholder down on the track. This latter effect is produced at the

opposite end of the workholder by a tension spring 103 shown in Figure 4 and at the left end of Figure 1. This spring is connected to the workholder and to the framework by pins 105 secured to the respective parts.

The manner of mounting the rolling workholder upon the track and preventing slippage may be varied. For example, in Figures 6 and 7, I have shown a connecting link 110, one end of which is pivotally connected by a pin 112 to the track 60^a. The other end of the link is pivotally connected to the workholder by a pivot pin 114.

A similar result may be accomplished in the manner shown in Figure 8, in which the slippage is prevented by a stationary rack 120, which is engaged by a gear 122 formed on the rolling workholder.

Still another form is illustrated in Figure 9, in which case a pin 130 is secured to the rolling workholder and slides in a vertical slot 132 formed in a plate 134 secured at the side of track 60^b.

The operation of the machine will be evident from the foregoing. Assuming the machine to be set in proper position for starting, when the power mechanism rotates the wide-faced pinion 32, the latter will rotate the gear 30 and through it the work spindle 2. This will produce two effects, viz., the rotation of the hob about its own axis and the axial travel of the hob due to the action of the lead screw 20 and lead nut 21. The power shaft 46 will rotate cam shaft 96 and cam 94, thus causing a vertical movement of the band or strap 80 and this in turn will cause the workholder to roll back and forth upon the track 60, thus moving the hob in substantially a straight radial line toward and from the grinder to produce the relief in the work. The amount of the relief may be regulated by suitably adjusting the block 85 along arm 88.

It will be evident that this construction not only makes it possible to produce a substantially rectilinear movement of the hob toward and from the grinder, but does it as the result of a rolling action of the work holder in distinction to a sliding action. It is well known that a rolling action produces less friction than a sliding action, and the result is that in my machine friction will be reduced to a minimum. This not only reduces the amount of power and lubrication required but, more important still, minimizes the wear which will occur upon the parts which determine the accuracy of the work. As previously explained this latter characteristic is of great importance in view of the small degree of tolerance permissible in the grinding of hobs. Another advantage of my machine is that the parts may be made large, that is, the tracks and treads may be of comparatively large dimensions, thus still further making for accuracy of operation and reduction of wear.

One of the characteristics of design by which I am enabled to obtain the three-fold movement of the hob with such a simple train of gearing is based upon the fact that the surface of the tracks 60, if extended, would be tangential to the pitch circle or pitch cylinder of the wide faced pinion 32. In other words, the plane of the tracks, if projected, would be tangent to said pitch circle and to the pitch circle of gear 30.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A grinder having a framework provided with a track, a tool holder and a workholder, one of which is adapted to roll upon the track and the other is adapted to bring the tool and the work into contact at a point approximately as far from the plane of the track as the radius of the part which rolls upon the track.

2. A grinder having a framework provided with a track, a tool holder, a workholder having a roller adapted to roll upon the track, the tool holder being adapted to present the tool to the work at a point approximately as far from the plane of the track as the radius of the workholder, and means for rolling the workholder back and forth along the track to thereby move the work bodily and approximately radially toward and from the tool.

3. A grinder having a framework provided with a track, a cylindrical work carrier for rolling on said track, a work spindle, concentric with the work carrier and rotatable therein, means for rolling the roller along the track, means for independently rotating the spindle, and a tool holder adapted to present the tool to the work at a point approximately as far from the plane of the track as the radius of the cylindrical work carrier.

4. A hob grinder having a grinding element, a work supporting roller, a main frame having a plane surface for supporting said roller, means for preventing slipping between said roller and its said supporting surface, means for rolling the roller back and forth toward and from the grinder, a work spindle journaled in the roller, concentrically therewith, and means for rotating the work spindle about its axis.

5. A hob grinder having a grinding element, a work supporting roller, a main frame having a plane surface for supporting said roller, means for preventing slipping between said roller and its said supporting surface, means for rolling the roller back and forth toward and from the grinder, a work spindle journaled in the roller, concentrically therewith, means for rotating the

work spindle about its axis, and a lead screw for simultaneously shifting the work spindle longitudinally.

6. A hob grinding machine having a main frame, a grinder mounted thereon, a track on the main frame, a work holder having a roller adapted to roll on said track to move the work toward and from the grinder, means for causing the work holder to roll back and forth upon the track, and a strap intervening between the roller and the track, one end of the strap being secured to the track and the other end to the tread of the roller for preventing slipping.

7. A hob grinding machine having a main frame, a grinder mounted thereon, a track on the main frame, a workholder having a roller adapted to roll on the track to move the work toward and from the grinder, a connector fastened to the work holder eccentrically, means for alternately pulling and releasing the connector to thereby cause the roller to roll forward on the track, and resilient means for returning the roller when the connector releases it.

8. A hob grinding machine having a main frame, a grinder mounted thereon, a work spindle, means for rotating the work spindle about its axis, means for simultaneously shifting the work spindle along its axis in accordance with the lead of the hob, a frame in which the work spindle is journaled, rollers on said frame concentric with the axis of the work spindle, tracks on the main frame for supporting the rollers, positive acting means for rolling the rollers forward intermittently toward the grinder, and resilient means for rolling the roller backward away from the grinder.

9. A hob grinding machine having a main frame provided with a grinder, a work spindle, a rolling frame in which the work spindle is journaled, said rolling frame having rollers concentric with the work spindle, tracks on the main frame for supporting the rollers, a gear wheel for rotating the work spindle and a pinion for rotating said gear, the pitch circle of the pinion being tangent to the projected plane of the tracks.

10. A hob grinding machine having a main frame provided with a grinder, a work spindle, a lead screw on the work spindle, a gear wheel fastened to the work spindle for rotating and shifting it, a wide faced pinion meshing with said gear, a rolling frame in which the work spindle is journaled, said rolling frame having rollers concentric with the spindle tracks for supporting said rolling frame, the plane of the tracks, if extended, being tangent to the pitch circle of the pinion, and means for rolling said rolling frame back and forth on tracks to produce relief in the teeth of the work.

In witness whereof, I have hereunto subscribed my name.

CARL G. OLSON.