Oct. 10, 1944. M. JELLIS 2,360,235

GRINDING MACHINE

Filed June 10, 1943 2 Sheets-Sheet 1

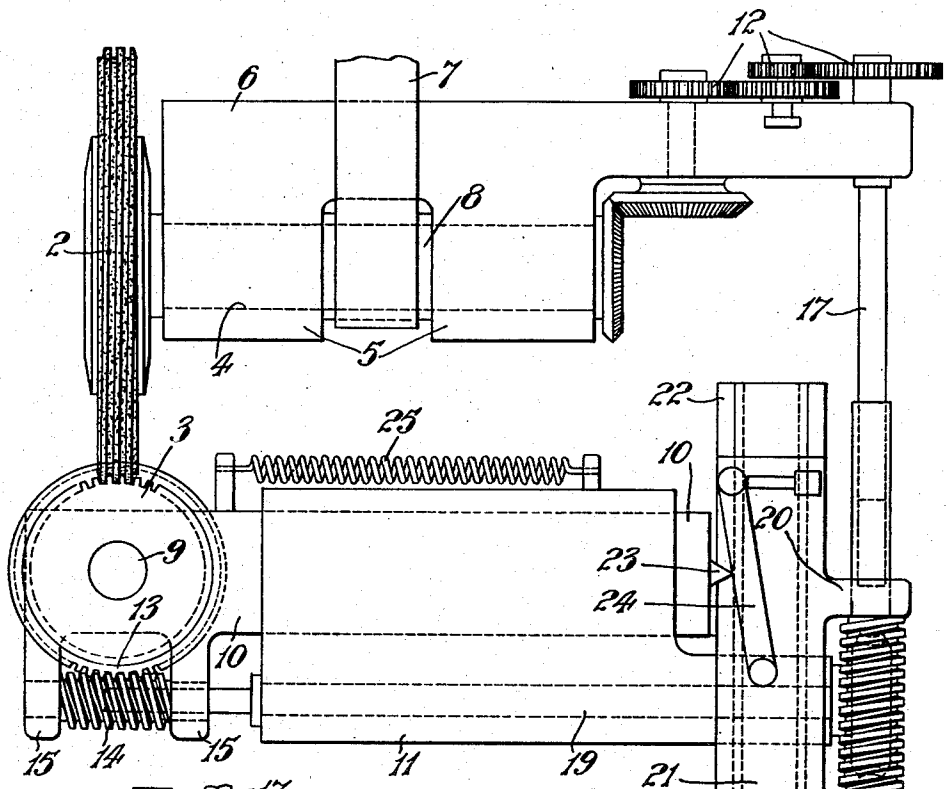


Fig. 1.

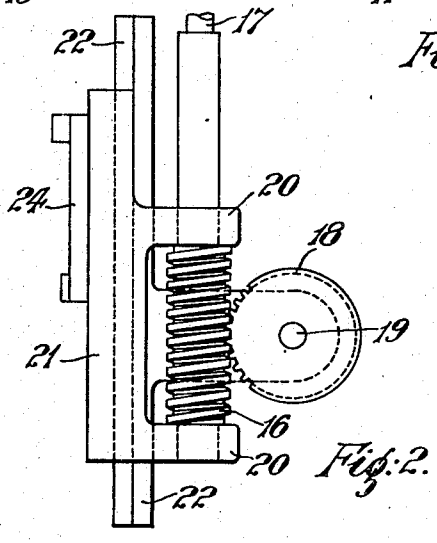
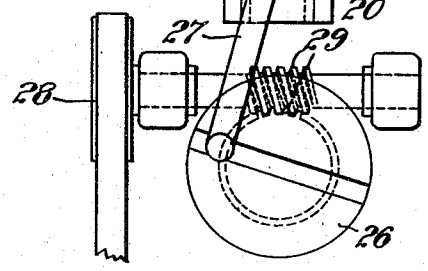


Fig. 2.



Inventor
Morgan Jellis
by Babcock & Babcock
Attorneys

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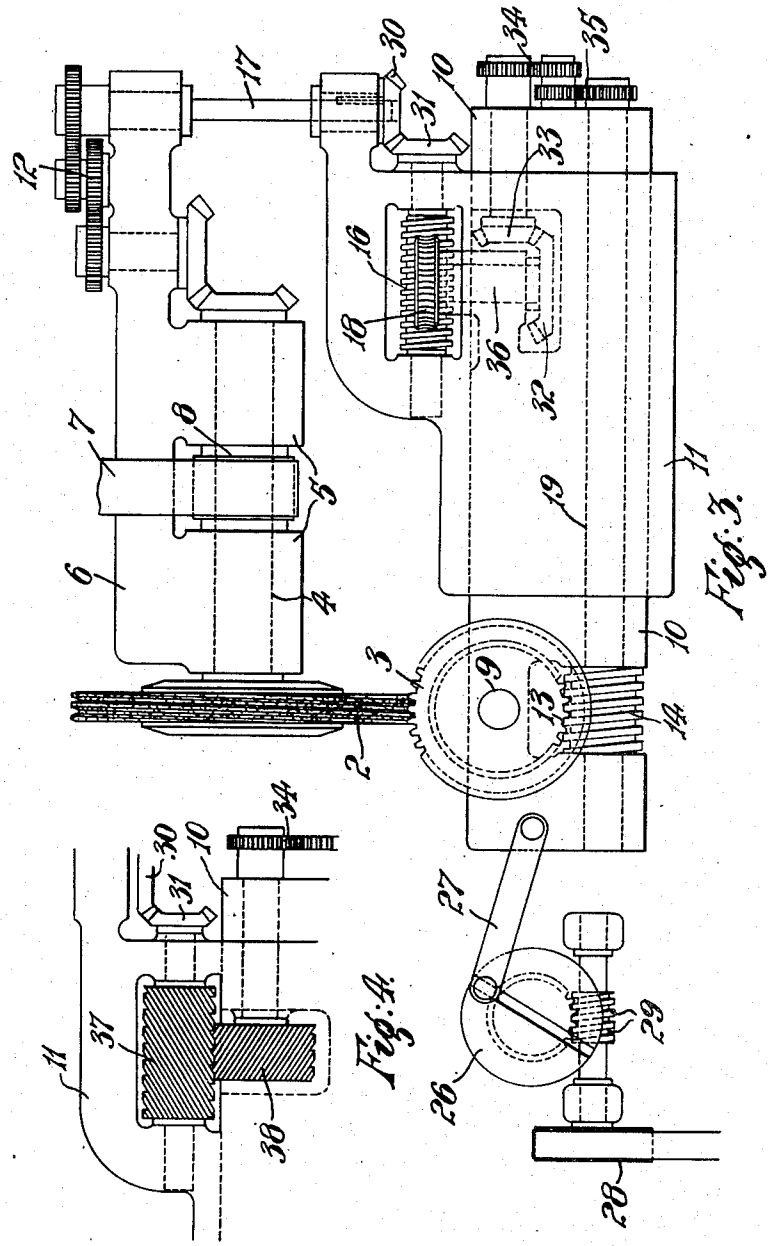


Fig. 3.

Fig. 4.

Inventor
Morgan Jellis
by Babcock & Babcock
Attorneys

UNITED STATES PATENT OFFICE

2,360,235

GRINDING MACHINE

Morgan Jellis, Peterborough, England, assignor to Coventry Gauge & Tool Company Limited, Fletchamstead, Coventry, England

Application June 10, 1943, Serial No. 490,316
In Great Britain August 14, 1942

9 Claims. (Cl. 51—123)

This invention relates to the production of gear tooth and like profiles by a grinding operation in which a spiral ribbed grinding wheel profiled to the rack form of the pitch desired is employed.

The object of the present invention is to provide an improved machine embodying this principle.

A further object of the invention is to provide an improved arrangement for distributing the wear uniformly across the full width of the grinding wheel.

The invention also has for its objects to avoid overrun or idle strokes and backlash and reversing shocks, thereby eliminating loss of time and contributing to long life and accuracy of the machine.

According to the present invention the improved machine is characterized in that, in addition to its normal rotation in timed relation with the grinding wheel, the work blank is moved laterally to and fro across the wheel with a rolling motion so as to distribute the wear uniformly across the full width of the wheel and at the same time to ensure accuracy of the involute profile of the gear teeth.

In the accompanying drawings,

Figure 1 illustrates a lay out embodying the present invention.

Figure 2 is a detail view of the mechanism employed for traversing the work blank across the grinding wheel and at the same time giving it a rolling motion.

Figure 3 is a view similar to Figure 1 of an alternative construction.

Figure 4 is a detail view of alternative means for rolling the work-blank in engagement with the grinding wheel.

Referring to the drawings, 2 represents the grinding wheel and 3 the work-blank in which gear tooth or like profiles are to be produced by a grinding operation.

The grinding wheel spindle 4 is rotatably mounted in bearings 5 in a head stock 6 and can be driven at the desired speed in any suitable manner, as by means of a belt 7 and pulley 8 or an electric motor.

The work-spindle 9, which is rotatably mounted in a work-head 10 slidably mounted in a fixed headstock 11, is driven from the wheel spindle 4 through a change speed gear 12, by means of worm and wheel gears in one of which the worm-wheel 13 is secured to the work-spindle 9 and the worm 14 rotatably mounted in bearings 15 in the work-head 10. The worm 16 of the other of the two worm gears has a sliding splined connection with its operating shaft 17 and is in constant mesh with a worm wheel 18 fixed to a spindle 19 rotatably mounted in the headstock 11 and having a sliding splined connection with the worm 14 of the first gear. Means, preferably independently driven, are provided for reciprocating the worm 16 axially relatively to its associated worm wheel 18, and at the same time for operating the work-head 10 to move the work blank 3 to and fro in a lateral direction across the face of the helically ribbed grinding wheel 2. For this purpose the said worm 16 which, as shown in Figure 2, is in constant mesh with its worm wheel 18 and is rotatably mounted in lugs 20 on a slide 21 arranged and adapted for independent reciprocation on a guide plate 22 in a direction parallel with the axis of said worm 16. At the same time the work-head 10 is moved bodily to and fro in the headstock 11 in a direction at right angles to the axis of the work-spindle 9 by means of a stylus 23 on the work-head 10 co-operating with a sine bar 24 carried by the said slide 21. The inclination of the sine bar may be varied and is set by means of slip gauges equalling the pitch radius of the gear to be ground. During the return movement of the work-head the stylus is held in contact with the sine bar by means of the tension spring 25 one end of which is attached to the work-head and the other to the headstock 11. The slide 21 may be independently operated in any suitable manner as by means of an electric motor or, as shown, by a disc crank 26 having an adjustable connection with the said slide by means of a connecting rod 27, and driven by belt and pulley 28 through worm gear 29.

During the operation of the machine the work blank 3, in addition to its rotary motion in timed relation with the speed of rotation of the helically ribbed grinding wheel 2, is rolled backwards and forwards in engagement with the latter by the axial movement of the worm 16, the effect of which is to alternately accelerate and retard the speed of rotation of the worm wheel 18 and hence the work-blank. At the same time the work blank is also traversed backwards and forwards across the face of the grinding wheel with a parallel motion by the co-action between the sine bar 24 on the slide 21 and the stylus 23 on the work-head 10.

In the alternative construction shown in Figure 3 in which parts corresponding with those shown in Figure 1 are designated by similar reference numerals, the work-spindle 9 is driven in

timed relation with the helically ribbed abrasive wheel 2, as before, except that in this case the arrangement of the drive necessitates the use of bevel gear 30, 31 between the worm 16 and the shaft 17, and also the use of bevel gear 32, 33 between the worm wheel 18 and the worm gear 13, 14 for the work-spindle 9. In order to provide for variations in the diameter of the work 3 auxiliary change gears 34, 35 may be introduced into the drive between the worm wheel 18 and the spindle 19 of the worm 14, said gears being carried by the sliding work head 10, as shown. The said alternative construction is also distinguished from that shown in Figure 1 in that the use of the sine bar 24 and slide 21 are dispensed with, the sliding work-head 10 being in this case operated directly from the independently driven crank disc 26 by means of the adjustable connecting rod 27. The arrangement of the worm and wheel gear 16, 18 is also different, the worm in this case being mounted in the work headstock 11, while the spindle 36 of the worm wheel is rotatably mounted in the sliding work-head 10 and together with the bevel gear 32, 33 and auxiliary change speed gear 34, 35 move therewith. In other respects the operation is the same as in Figure 1, that is to say, the work speed in relation to the speed of the abrasive wheel 2 during the reciprocating motion of the work-head 10, is modified by the angular displacement of the worm 16 and worm wheel 18 resulting from the axial travel of the latter along and in mesh with the axially stationary worm 16.

As shown in Figure 4 spiral gears 37, 38 may be substituted for the worm and wheel gear 16, 18.

The grinding operation is continuous, the work remaining in contact with the grinding wheel until the operation of forming the gear teeth is completed.

The mechanism of the machine is arranged for unidirectional rotation, a feature which is largely responsible for the accuracy and durability of the improved machine.

Accuracy of division is not dependent upon a dividing plate but principally upon the accuracy of the worms and worm wheels of the mechanism which for the purposes of facilitating manufacture may all be made identical in pitch.

I claim:

1. A machine for producing gear tooth and like profiles by a grinding operation, comprising an appropriately formed grinding wheel, a work-blank holder, mechanism for rotating said work-blank holder in timed relation with said grinding wheel, traversing means for traversing said work-blank holder across the operative face of said grinding wheel, and modifying means acting to superimpose upon the normal rotary movement of said holder alternate partial rotations in reverse directions about the axis of said holder.

2. A machine for producing gear tooth and like profiles by a grinding operation, comprising an appropriately formed grinding wheel, a work-spindle adapted to receive a work-blank, mechanism for rotating said wheel and spindle in timed relation with each other, a sliding work-head carrying said spindle, means associated with said mechanism and work-head for traversing the work-blank across the operative face of the grinding wheel, and modifying means acting to superimpose upon the normal rotary movement of said spindle alternate partial rotations in reverse directions about the axis of said spindle.

3. A machine for producing gear tooth and like profiles by a grinding operation, comprisi an appropriately formed grinding wheel, a wo head, a spindle rotatably mounted in said wo head and adapted to receive a work-blank, mec anism for rotating said grinding wheel and spi dle in timed relation with each other, means a ing independently of said mechanism for reci rocating said work-head in a direction at rig angles to said spindle, and modifying means act ated by said independent means for superimpo ing upon the normal rotary movement of sa spindle alternate partial rotations in reverse d rections about the axis of said spindle.

4. A machine for producing gear tooth ar like profiles by a grinding operation, comprisir an appropriately formed grinding wheel, a work spindle adapted to receive a work-blank, mecha nism for rotating said wheel and spindle in time relation with each other, said mechanism includ ing worm and wheel gear, means acting inde pendently of said mechanism for reciprocatin said work-head in a direction at right angles t said spindle, and means associated with said in dependently acting means for reciprocating sai worm in an axial direction relatively to and i mesh with its associated worm wheel.

5. A machine for producing gear tooth and like profiles by a grinding operation, comprising an appropriately formed grinding wheel, a work-head, a spindle rotatably mounted in said work-head and adapted to receive a work-blank, means for reciprocating said work-head in a direction at right angles to said spindle, and mechanism for rotating said grinding wheel and spindle in timed relation with each other, said mechanism including a worm wheel adapted for rolling engagement with an axially stationary worm during reciprocation of said work-head.

6. A machine for producing gear tooth and like profiles by a grinding operation, comprising an appropriately formed grinding wheel, a work-head, a spindle rotatably mounted in said work-head and adapted to receive a work-blank, means for reciprocating said work-head in a direction at right angles to said spindle, and mechanism for rotating said grinding wheel and spindle in timed relation with each other, said mechanism including skew gearing one member of which is adapted for movement in the direction of its axis relatively to and in mesh with the other during reciprocation of said work-head.

7. A machine for producing gear tooth and like profiles by a grinding operation, comprising a wheel head, an appropriately formed grinding wheel rotatably mounted therein, a work-head mounted for reciprocation in a direction parallel with the axis of said grinding wheel, a spindle rotatably mounted in said work-head and adapted to receive a work-blank, mechanism for rotating said grinding wheel and spindle in predetermined timed relation with each other, said mechanism including worm and wheel gearing, a slide carrying said worm and adapted for independent reciprocation, a sine bar carried by said slide and adapted to co-operate with a stylus on said work-head, and means for maintaining contact between said stylus and sine bar.

8. A machine for producing gear tooth and like profiles by a grinding operation, comprising a wheel head, an appropriately formed grinding wheel rotatably mounted therein, a work-head mounted for reciprocation in a direction parallel with the axis of said grinding wheel, a spindle rotatably mounted in said work-head and adapted to receive a work-blank, mechanism for rotat-

ing said grinding wheel and spindle in pre-determined timed relation with each other, said mechanism including a worm wheel carried by said work-head, and in constant mesh with an axially stationary worm, and means acting independently of said mechanism for reciprocating said work-head.

9. A machine for producing gear tooth and like profiles by a grinding operation, said machine comprising an appropriately formed grinding wheel mounted for rotation about its axis, and a work holder for presenting the work-blank to the operative face of the grinding wheel, in combination with mechanism for positively actuating said work-holder to rotate the work-blank in timed relation with the rotation of said grinding wheel, independently operated means for traversing said work-blank across the operative face of said grinding wheel, and modifying means actuated by said independent means and acting to superimpose upon the normal rotary movement of said work-holder alternate partial rotations in reverse directions about the axis of said work-piece.

MORGAN JELLIS.