Aug. 14, 1923. 1,465,068

A. TURNER

UNIFORMLY DRIVEN CAM GRINDING APPARATUS

Filed Sept. 23, 1918 2 Sheets-Sheet 1

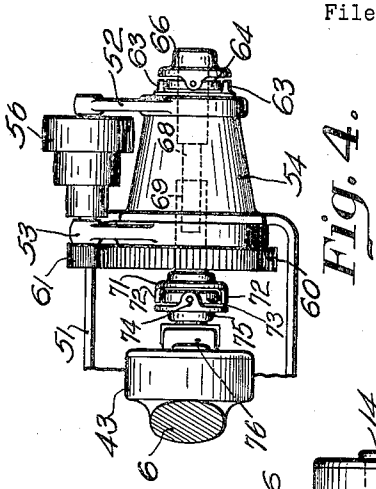


Fig. 4.

Fig. 1.

INVENTOR
Albert Turner
BY
Clayton L. Jenks
ATTORNEY

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A. TURNER

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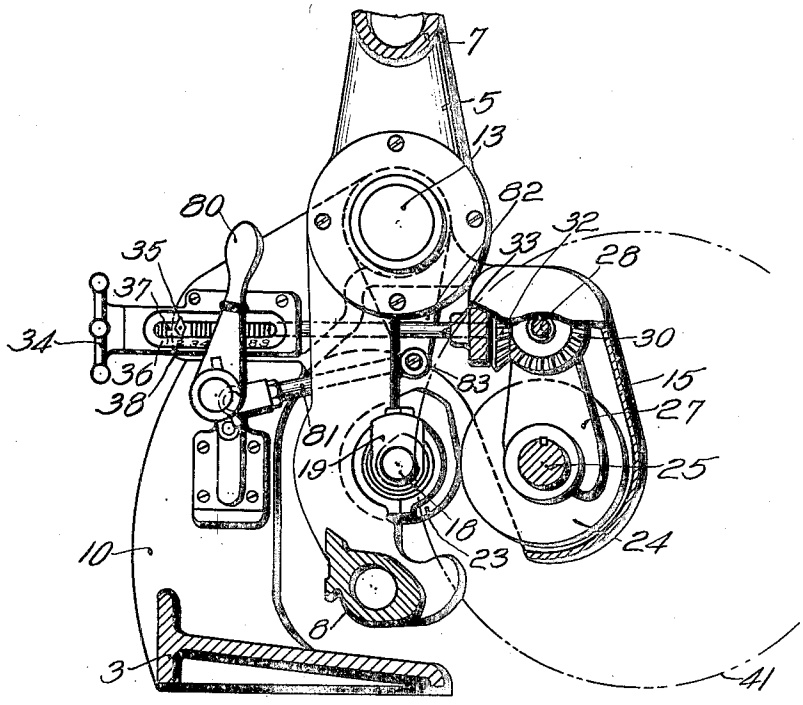


Fig. 2.

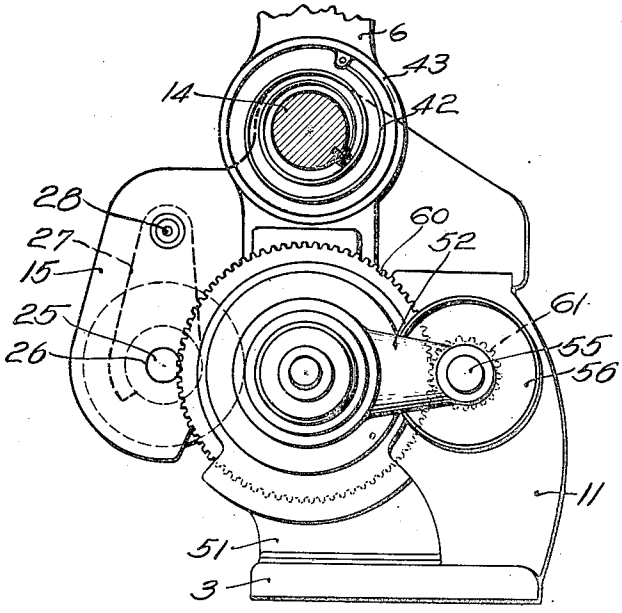


Fig. 3.

INVENTOR
Albert Turner
BY
Clayton F. Jenks
ATTORNEY

Patented Aug. 14, 1923. 1,465,068

UNITED STATES PATENT OFFICE.

ALBERT TURNER, OF WORCESTER, MASSACHUSETTS, ASSIGNOR TO NORTON COMPANY, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

UNIFORMLY-DRIVEN CAM-GRINDING APPARATUS.

Application filed September 28, 1918. Serial No. 256,082.

To all whom it may concern:

Be it known that I, ALBERT TURNER, a citizen of the United States of America, residing at Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Uniformly-Driven Cam-Grinding Apparatus, of which the following is a full, clear, and exact specification.

This invention relates to machines for grinding bodies having non-circular perimeters and more particularly to a mechanism for uniformly rotating the work in a cam grinding apparatus.

In the art of grinding cams, the devices generally used involve a swinging frame which supports the work to be ground against a grinding wheel and is rocked back and forth by means of a master cam rotatably mounted on the frame in contact with a cam follower fixed on the grinding machine.

In such constructions the master cam and the work are rotated by a gear or belt connection with a shaft fixed relative to the swinging frame pivots. Because of this type of driving connection, the work is not rotated with a uniform angular velocity, but is retarded or accelerated, depending upon the direction of rotation, when the frame swings to permit the wheel to grind the rise or the drop on the cam. This variation in grinding results in chatter marks and a departure from the true pattern to be ground, and so is highly objectionable.

It is accordingly an object of my invention to provide a grinding apparatus for cams or other curved objects having non-circular perimeters, in which the relative angular velocities of the work is maintained substantially uniform, while the work and wheel are reciprocated relative to each other to permit grinding the work surface as the point of contact varies in radial distance from the work center.

With this and other objects in view as will be apparent from the followiwng disclosure, my invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

In the drawings in which like reference numerals indicate like parts:

Fig. 1 is a front elevation partly broken away of a swinging frame embodying my invention as attached to a grinding machine table;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a right-hand elevation of the machine shown in Fig. 1; and

Fig. 4 is a detail plan view of the driving mechanism.

My invention contemplates the provision of a grinding apparatus involving a rotatable grinding wheel and a work support adapted to present work to be ground continuously to the grinding surface of the wheel. The wheel and the work are moved relative to each other in a path transverse to the work axis, in accordance with the variation in the radial distance of the work center from the surface of contact with the grinding wheel, and means are provided for imparting a uniform angular motion to the movable rotating body during this transverse movement. While it is immaterial, so far as this invention is concerned, whether the grinding wheel or the work itself reciprocates in such transverse motion, I prefer to mount the grinding wheel on a fixed base, and reciprocate the work relative thereto. This reciprocating motion may be effected as illustrated by mounting the work on a swinging frame and automatically rocking the frame by means of a rotating pattern engaging a shoe, one being mounted on the frame and the other on the base which supports the swinging frame. To rotate the work at a uniform angular velocity, I preferably make use of a flexible work-driving connection between the work and the master cam shaft, and a fixed driving shaft.

In order that the invention may be more fully understood, reference is had to the drawings illustrating one embodiment thereof in which I have shown the usual form of slidable table 1 mounted on the grinding machine base and carrying a swivel table 2 on which is mounted the swinging frame base 3. The work may be reciprocated by means of a swinging frame comprising vertical standards 4, 5 and 6 connected together by top and bottom cross pieces 7 and 8 which is supported by the upright arms 9, 10 and 11 on the base. The frame is mounted on pins 12, 13 and 14 which are carried by the vertical arms 9, 10 and

11. A casing 15 is also supported by the two upright arms 10 and 11 and is adapted to carry the master cam follower and its operating mechanism, presently to be described.

The work to be ground, illustrated in the drawings as a cam shaft, is supported by suitable means on the lower portion of the frame. This support may comprise a footstock 16 having an adjustable centering pin 17 mounted therein for supporting one end of the work. The other end is supported by the centering pin 18 which is mounted in suitable bearings in the vertical standard 5 of the swinging frame. The work may be rotated by suitable mechanism such as a lug 19 on the pin 18 engaging a driving dog 20 clamped to the work, as by means of a set screw.

In the present embodiment, I have illustrated the master cam shaft as being mounted on the frame and axially aligned with the work. This cam shaft 22 may be integral with or rigidly connected to the centering pin 18 of the work in order that the work and the pattern may rotate synchronously and simultaneously. The outer end of this cam shaft is mounted in suitable bearings in the standard 6. Master cams 23 are removably located on this shaft in desired spaced relation and are adapted to rotate against a master cam follower which is mounted in the casing 15 on the fixed base. This follower may be a roller 24 mounted on a spindle 25 carried by suitable bearings 26 in the fixed casing 15, this roller being adapted to be rotated by frictional contact with the master cam, in order that a new surface may be constantly presented to the cam and thereby obviate any error due to wear on the roller.

In order that the roller 24 may be adjusted to a position opposite any one of the master cams, it is mounted loosely on the shaft 25 and adapted to be moved along the same by suitable means. In the embodiment illustrated, this may comprise a yoke 27 straddling the roller 24, which is moved longitudinally by a screw-threaded shaft 28 mounted in bearings 29 in the walls of the casing 15 and cooperating with threads in the yoke. This shaft 28 is rotated by a bevel gear 30 thereon, which meshes with another bevel gear 32 mounted on the shaft 33, which is rotated by a suitable hand-operated mechanism 34. The position of the master cam roller may be noted by means of a pointer 35 traveling over a scale 36, this pointer 35 being carried by a block 37 non-rotatably keyed to the casing 38 and threaded on the shaft 33, whereby rotation of the hand wheel slides the block.

It is accordingly seen that in the construction so far described, when the master cam shaft 22 is rotated, the irregularly shaped master cams push against the master cam roller 24 which is mounted on fixed supports and so swing the frame and move the master cam shaft and the work which is axially aligned therewith in a transverse motion relative to their axes. These parts move in the arc of a circle about the center of the pivots 12, 13 and 14 of the frame. By this means the cam shaft 40 is reciprocated relative to the grinding wheel 41, herein diagrammatically shown, this grinding wheel being mounted on fixed supports on another part of the grinding machine, whereby it may be rotated with uniform velocity by suitable driving mechanism.

In order to insure uniform swinging motion of the frame and prevent the same jumping as the grinding wheel passes over a high point on the work, suitable mechanism may be provided to hold the work firmly against the grinding wheel. In the form illustrated, this comprises two spiral springs 42 suitably fastened at their exterior portions to the uprights 5 and 6 within the dust-proof boxes 43 and fastened at their inner ends to the pins 13 and 14. These pins 13 and 14 are fixed to the arms 10 and 11 on the base by means of set screws 44, so that a rise on the master cam forces the frame to swing about the fixed centers against the reactive pull of the springs 42. The tension of these springs may be adjusted by loosening the set screws 44 and rotating the pins within the bearings to a desired position.

Suitable mechanism may be provided also for taking up any back lash in the driving mechanism and to prevent the swinging frame from moving irregularly. This may comprise a brake drum 46 keyed to the shaft 22 to rotate therewith. This drum is engaged by two brake members 47 which constitute a yoke clamping against the periphery of the drum, these members being hinged together at 48 and held together at their lower end by suitable clamping means 49, the pressure of these clamping means being adjustable to give the desired tension.

Since in this type of grinding apparatus either the wheel or the work must move transversely relative to the axis of grinding, and in the present embodiment the work is reciprocated, it is necessary that a driving connection be made with this reciprocating work from a stationary source of power. To avoid variation in the angular velocity of the master cam shaft 22 and the driving spindle 18, I provide a flexible driving connection between these movable parts and the fixed source of power and this connection is so constructed that uniform circular motion at one end is converted into a uniform circular motion at the other end thereof.

In the form illustrated, the standard 51 is mounted on the base 3 which carries the

swinging frame and is provided with arms 52 and 53 (Figs. 3 and 4) clamped to an extension 54 of the standard. These arms carry a shaft 55 on which pulleys 56 are mounted, these pulleys being adapted to be driven by any suitable outside source of energy. The extension 54 is a hollow, preferably conical member having bearing portions 57 and 58 therein. Rotatably mounted in these bearings is a conical member 59 having a projecting portion 60 provided with gear teeth thereon which mesh with the gear wheel 61 on the shaft 55.

While this driving mechanism may obviously be of other shape, I have made it of a conical shape in order to economize space and provide a compact mechanism for my flexible driving connection. It has a large central opening so that the telescoping linkage therein may swing with the frame. A plate 62 is fastened on the small outer end of the conical driving member 59. This plate is provided with projecting lugs 63 (Fig. 4) which carry a ring 64 pivotally mounted thereon. This ring 64 in turn has projecting pins mounted in lugs 65 on the member 66 of the driving mechanism. The member 66 has rigidly fixed thereto an inwardly projecting shaft 67 having a reduced portion 68 which telescopes within a hollow shaft 69, and is keyed thereto for rotative movement with the hollow shaft while sliding longitudinally therein. A second universal joint similar to the one above described is provided to connect this hollow shaft 69 with the cam shaft 22. This joint may comprise, as illustrated, the member 71 on the hollow shaft 69 having lugs 72 thereon which pivotally carry a central ring 73 which in turn is pivotally mounted on lugs 74 of the end piece 75 affixed to the shaft 22. In order to strengthen the frame and support the brake drum and the shaft 22 adjacent the universal coupling, I provide an arm 76 depending from the upright member 6 of the frame, a suitable bearing being provided in this arm for the shaft 22.

In order that the frame may be moved back from the grinding wheel for the insertion or removal of work, I provide any suitable mechanism comprising, for example, the hand lever 80 pivotally mounted on the fixed standard 10 of the grinding machine and having a rod 81 eccentrically pivoted thereto and pivotally connected with a further lever 82 which is pivotally mounted on the pin 13. A pin 83 projecting from the joint between levers 81 and 82 engages the upright standard 5 of the frame and causes it to swing backwards when the handle 80 is moved.

The operation of the device is obvious from the above disclosure. When it is desired to grind an irregular body such as a cam on a cam shaft, the work is properly mounted in the machine and master cams inserted and correctly positioned relative to the work, these masters corresponding with the cams to be ground. The frame is permitted to swing forward by operation of the lever 80 so that the work contacts with the grinding wheel 41. Upon applying power to the pulley 56 this rotative motion is communicated through the gear 61 to the gear 60, causing the universal joints and the telescoping members to rotate therewith. No matter what position the frame assumes in swinging back and forth the flexible connection takes care of this movement and causes the shaft 22 to rotate at a substantially uniform angular motion with the member 60. The work 40, being in alignment with and rotating synchronously with the shaft 22, is also moved at the same angular velocity.

What I claim is:—

1. In a grinding machine a rotatable work support mounted to move in a path transverse to the work axis, a non-swinging rotatable driving member substantially aligned with said work support, and means comprising flexible connections between said member and support for imparting uniform angular motion to the work support during such transverse movement.

2. In a grinding machine, a movable work support, means to move the same in a path transverse to the axis of the work, a work driving shaft mounted on the support, a rotatable driving shaft mounted in a fixed position in substantial alignment with the work driving shaft and flexible connections between said shafts whereby the work may be rotated uniformly as the work support moves.

3. In a grinding machine, a swinging frame, a work drive mounted thereon to move in a path transverse to the work axis as the frame swings, a master cam rotatably mounted on the frame, a fixed follower in contact with the cam so that rotation of the master cam swings the frame, a fixed driving shaft approximately aligned with the work drive and flexible means connecting said shaft and work drive to rotate the work at a uniform angular velocity as the frame swings.

4. In a grinding machine, a frame mounted to swing in a path transverse to the axis of the work, a workholding device and a pattern shaft mounted on the frame in axial alignment, a grinding wheel, a rotatable pattern on said shaft, a follower fixedly mounted on the machine in contact with the pattern so that the frame is caused to swing by rotation of the pattern, a fixed driving device and flexible means operated by said driving device to rotate the work and pattern at a uniform angular rate.

5. In a grinding machine, a rotatable

work drive mounted to move in a path transverse to the work axis, a fixed driving shaft in approximate alignment with the work axis and a flexible connection between said shaft and work drive to rotate the work at a uniform angular velocity during its transverse movement.

6. In a machine for grinding work of non-circular perimeter, a rotatable grinding wheel, a frame movable relative to the wheel in a path transverse to the work axis, a rotatable work drive mounted on the frame, a rotatable pattern movable therewith, a follower fixed on the machine in contact with the pattern whereby rotation of the pattern moves the frame and work relative to the grinding wheel, a uniformly rotating driving shaft fixed on the machine and a flexible driving connection between said shaft and the work drive and pattern adapted to rotate the latter at a uniform angular velocity as the frame moves.

7. In a grinding machine, a movable work support, means to move the same in a path transverse to the axis of the work, a work driving shaft mounted on the support, a rotatable driving shaft mounted in a fixed position substantially parallel with the work driving shaft, a telescoping member between said shafts, and universal joints connecting the ends of said member with said shafts whereby the work may be rotated uniformly as the work support moves.

8. In a machine for grinding work having a non-circular perimeter, a rotatable grinding wheel, a frame movable relative thereto, a work support and drive on the frame, automatically operated mechanism to move the frame transversely relative to the axis of the grinding wheel and the work axis in accordance with a pattern, a uniformly rotatable driving shaft fixed on the machine, a telescoping shaft and universal joints connecting said telescoping shaft with the driving shaft and the work drive.

9. In a grinding machine, a base, a frame mounted thereon to swing in a path transverse to the axis of the work, a work rotating shaft mounted on said frame, a telescoping shaft, a universal joint connecting said shafts, a rotatable, hollow driving member mounted in fixed position on the base surrounding said telescoping shaft, a universal joint between the telescoping shaft and said driving member and means to rotate said driving member at a uniform rate.

Signed at Worcester, Massachusetts, this 26th day of Sept., 1918.

ALBERT TURNER.