July 14, 1936. S. J. HARLEY 2,047,869

GRINDING MACHINE

Filed Sept. 22, 1934 2 Sheets-Sheet 1

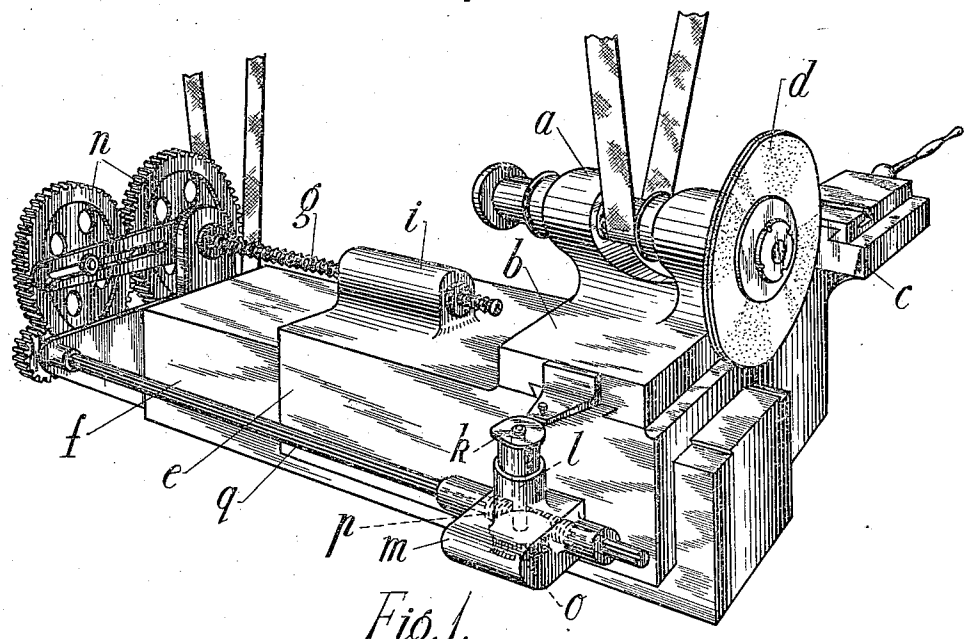


Fig. 1.

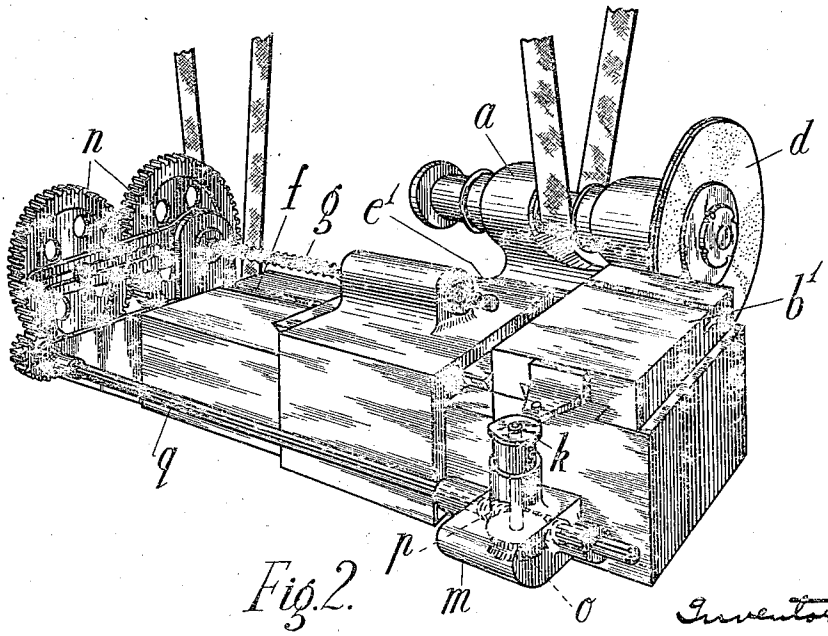


Fig. 2.

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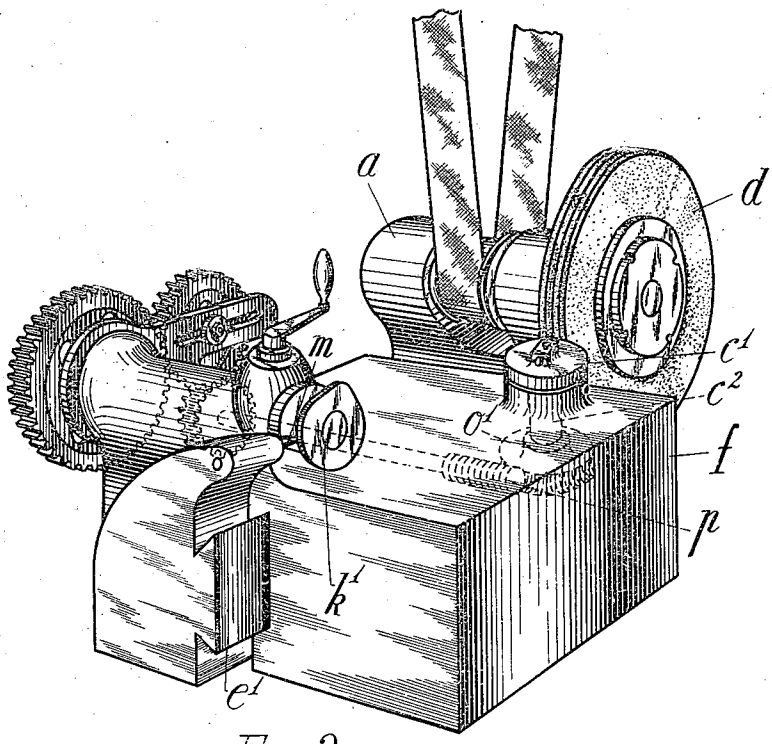


Fig. 3.

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GRINDING MACHINE

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Application September 22, 1934, Serial No. 745,138
In Great Britain October 10, 1933

7 Claims. (Cl. 51—35)

This invention relates to form grinding, including the formation of the operating surface of the grinding wheel itself as well as the formation or finishing of the work piece thereby.

The object of the invention is to provide constructions of grinding machine alternative to the kind in which for the purpose of generating by a grinding operation such continuous forms as are met with in screw threads and the screw thread profiles of screw thread chasers and the like, where a particular form has to be repeated without a break, provision is made for relative movement between the rotating grinding wheel and the work-piece or wheel cutter, as the case may be.

This relative movement is produced according to the present invention either by giving the wheel a compound movement relatively to the work-piece or cutter or by moving the wheel in one direction whilst at the same time the workpiece or cutter is moved in another direction.

The said movements are preferably rectilinear, the compound movement being the resultant of two simultaneous rectilinear movements, but in each case one may be angular or rotational.

In either case the two movements whether independent or constituents of a compound movement are of such relative and respective extent as to produce the form required by generation as distinguished from the movements derived by the use of a pattern or former.

The invention is particularly applicable to grinding machines for use in producing screw threads in solid material by means of a multi-ribbed grinding wheel.

In the accompanying drawings:—

Figure 1 is a perspective view of one form of grinding machine included within the present invention.

Figure 2 is a similar view of an alternative construction.

Figure 3 is a perspective view of a further modification.

In the arrangement shown in Figure 1 the movement which is required to generate the continuous form required either in the acting face of the grinding wheel or in the work-piece is given to the grinding wheel head, the work-piece or wheel cutter being stationary. For this purpose the grinding wheel head *a* is carried by a slide *b* which is arranged for movement relatively to the stationary holder *c* for the work-piece or cutter in two directions simultaneously, the combined effect of which is to cause the wheel whilst in contact with the work-piece or the cutter to move so that the locus of any point in the wheel is that of the form it is desired to produce in the work-piece or in the acting face of the wheel as the case may be. The relative direction and respective extent of the two movements simultaneously imparted to the wheel head may be varied at will according to the form it is desired to generate by the grinding or cutting operation.

In the construction shown, the slide *b*, carrying the grinding wheel head *a*, is moved in a direction at right angles to the plane of rotation of the grinding wheel *d* and for this purpose is mounted upon a second slide *e* arranged to move along the bed *f* of the machine in a direction parallel with the axis of the grinding wheel by means of a lead screw *g* rotatably mounted at one end in a bearing carried by the bed of the machine and adapted for rotation by hand or power. The threaded end of the lead screw, which is axially stationary, works in a tapped boss *i* on the slide *e*, the return movement of which can be effected by reversing the direction of rotation of the lead screw in any suitable manner, and preferably at a higher speed than that producing the forward movement of the slide. If, instead of a lead screw, a cam is employed to effect the movement of the slide *e* the latter, or a stylus thereon, can be kept in constant contact with the cam by means of a spring or a suspended weight, the cam spindle being mounted in bearings carried by the bed of the machine.

The simultaneous movement of the slide *b* in the other direction, for example, at right angles to the rotational axis of the grinding wheel, can be produced, as shown by means of a cam *k* the spindle *l* of which is rotatably mounted in a bracket *m* carried by the slide *e*. The form and rotation speed of this cam will be determined by the nature of the form to be ground in the work or cut in the wheel. The said cam may, as shown, be driven through suitable reduction gear *n* which can be varied at will by changing the gear wheels, from the spindle of the lead screw *g*, or cam, which is responsible for the movement of the slide *e*. For this purpose the spindle *l* of the cam *k* which operates the slide *b* may carry a worm wheel *o* meshing with a worm *p* which is slidably mounted on a feather on a shaft *q* which is driven by the reduction gear aforesaid.

Alternatively, the cam *k* operating the slide *b* may be carried by an extension of the lead screw *g*. Where the form to be produced either in the work-piece or in the acting face of the grinding wheel is that of the profile of a screw thread the ratio of the two movements imparted to the slide

b carrying the grinding wheel head a will be such that whilst the slide e moves through a distance equal to the pitch of the screw thread, the cam k which simultaneously reciprocates the slide b towards and away from the acting face of the grinding wheel, makes one complete revolution.

In the modification shown in Figure 2 one of the two movements, the resultant of which is responsible for the form required in the work or in the acting face of the wheel, is imparted to the grinding wheel head and the other to the work-piece or to the wheel cutting or truing device, as the case may be. In the construction shown, the wheel head a is carried by a slide e^1 which is arranged for movement along the bed f of the machine by means of a lead screw g, or by means of a cam, in the same manner as above described with reference to the slide e in Figure 1. In this case, however, the wheel cutter is carried by a slide b^1 which is adapted to be reciprocated across the bed of the machine by means of a cam k in a similar manner to the slide b in Figure 1. The movements of the two slides e^1 and b^1 take place simultaneously, being derived from a common shaft and are of such relative and respective extent as together to cause the cutter or the work-piece whilst in contact with the wheel to produce or receive the form required.

The cam k operating the slide b^1 can either be driven through reduction gear n by a shaft q and worm and worm wheel gear o, p, as shown, or may be mounted upon an extension of the lead screw g operating the slide e^1.

Where the form to be produced or trued, either in the wheel or in the work-piece, is that of a screwthread profile, the ratio of the movements of the slides b^1, e^1 will be such that whilst the slide e^1 moves through a distance equal to the pitch of the thread profile the cam k operating the slide b^1 makes one complete revolution. As an alternative to the construction shown in Figure 2, the slide b^1 carrying the cutter or the work-piece, can be moved along the bed of the machine across the operating face of the wheel by means of a lead screw or a cam, in which case the wheel head will at the same time be moved to and fro across the bed of the machine by means of a cam.

In the further modification shown in Figure 3 the grinding wheel cutter or the work-piece c^1 is fixed to a spindle c^2 journalled in the bed f of the machine so as to be capable of rotation in a plane at an angle to the plane of rotation of the grinding wheel. The grinding wheel head in this case is carried by a transverse slide e^1 and is moved towards and away from the cutter or work-piece c^1 by means of a cam k^1 which is carried by a shaft rotatably mounted in the bed of the machine and is held in contact with a stylus m on the transverse slide e^1 by means of a spring or weight (not shown). The spindle c^2 can be driven by means of worm and wheel gear o^1, p^1, as shown, or in any other suitable manner and, together with the cam-shaft, is operated from a common shaft so that there is a positive relation, which can be varied at will, between the reciprocating movement of the wheel head and the angular or rotary movement of the cutter or the work-piece.

Alternatively, the cutter or the work-piece may be rigidly mounted on a slide arranged to be reciprocated across the bed of the machine towards and away from the operating face of the grinding wheel, and the wheel head arranged to have an angular movement relatively to the cutter or work-piece about a fixed axis at an angle to its normal axis of rotation.

Instead of giving an angular movement to the wheel head and a rectilinear movement to the wheel cutter or the work-piece, or vice versa the work-piece or cutter, or the wheel head may be fixed and the wheel head or the work-piece or cutter as the case may be, may be carried by a reciprocating slide and also have an angular movement thereon about an axis which in the case of the wheel head would be at an angle to the rotational axis of the wheel.

In every case, the grinding wheel can either be driven by belt gear as shown, or by means of an independent electric or hydraulic motor carried by the wheel head.

The invention is not limited in its application to the formation of screw thread and gear tooth forms since by using cams of appropriate shape and rotational speed, the combined movements of the wheel head or of the cutter or work-piece, or the relative movements of the said wheel head and the cutter or work-piece as the case may be, may be caused to produce forms of any desired continuously repeated shape.

I claim:—

1. A grinding machine for the purposes described comprising a fixed frame, a grinding wheel head movable relatively thereto, a grinding wheel rotatably mounted in said head, a carrier adapted to receive a work-piece or a wheel-forming device, and interconnected means for imparting relative movement between said carrier and said grinding wheel simultaneously in two directions substantially normal to each other, the direction of one movement being across the face of the grinding wheel and the other movement being in a radial plane towards and away from the rotational axis of said wheel.

2. A grinding machine for the purposes described comprising a fixed frame, a slide movable relatively thereto a grinding wheel head carried by said slide, a grinding wheel rotatably mounted in said head, a carrier rotatably mounted in the said frame and adapted to carry a work-piece or a wheel forming or truing device and means for moving said slide in a plane normal to the operating face of the grinding wheel with a rectilinear movement towards and away from said rotating carrier while the grinding wheel is in contact with the work-piece or with the wheel truing or forming device, the rotational movement of the carrier and the rectilinear movement of said slide being both derived from a common shaft.

3. A grinding machine for the purposes described comprising a fixed frame, a rotatable grinding wheel, a head therefor rotatably mounted in said frame about an axis at an angle to the rotational axis of said wheel, a slide movable relatively to said frame, a carrier adapted to hold a work-piece or a wheel forming or truing device, said carrier being mounted on said slide, and means for moving said slide towards and away from the axis of said wheel with a rectilinear movement while the wheel is in contact with the work-piece with the wheel forming or truing device, the rotational movement of the grinding wheel head and the rectilinear movement of the slide being both derived from a common shaft.

4. A grinding machine for the purposes described comprising a fixed frame, a slide movable along said frame, a second slide movable upon and transversely to said first slide, a grinding wheel head carried by said second slide, a grinding wheel

rotatably mounted in said head, a lead screw for moving said first slide, a cam rotatably mounted on said first slide for reciprocating said second slide, a carrier normally stationary on said frame and adapated to hold a work-piece or a wheel forming or truing device, and means for simultaneously operating said cam and lead screw to give the grinding wheel head a compound movement relatively to said stationary carrier while the rotating grinding wheel is in contact with the work-piece or with the wheel forming or truing device.

5. A grinding machine for the purposes described comprising a fixed frame, a slide movable thereon, a grinding wheel head carried by said slide, a grinding wheel rotatably mounted in said head, a second slide movable on said frame in a direction transverse to the movement of the first slide and adapted to carry a work-piece or a wheel forming or truing device, a lead screw for moving said first slide, a cam rotatably mounted on the frame for moving said second slide, and means for simultaneously operating said cam and lead screw to cause relative movement between the grinding wheel head and the second slide while the grinding wheel is in contact with the work-piece or with the wheel forming or truing device.

6. Grinding machines for the purposes described according to claim 5 in which the cam operating the second slide is carried by an extension of the lead screw.

7. A grinding machine for the purposes described comprising a fixed frame, a slide movable in relation thereto, a grinding wheel head carried by said slide, a grinding wheel rotatably mounted in said head, a carrier rotatably mounted in said frame and adapted to hold a work-piece or wheel forming or truing device, a cam rotatably mounted in said frame for moving said slide, a shaft rotatably mounted in said frame for rotating said carrier and means common to both said cam and said shaft to cause relative movement between the wheel head and carrier while the grinding wheel is in contact with the work-piece or with the wheel forming or truing device.

STANLEY JAFFA HARLEY.