Dec. 19, 1950 W. G. BALDENHOFER 2,534,941

METHOD AND APPARATUS FOR GRINDING

Filed Jan. 16, 1948

FIG. 1

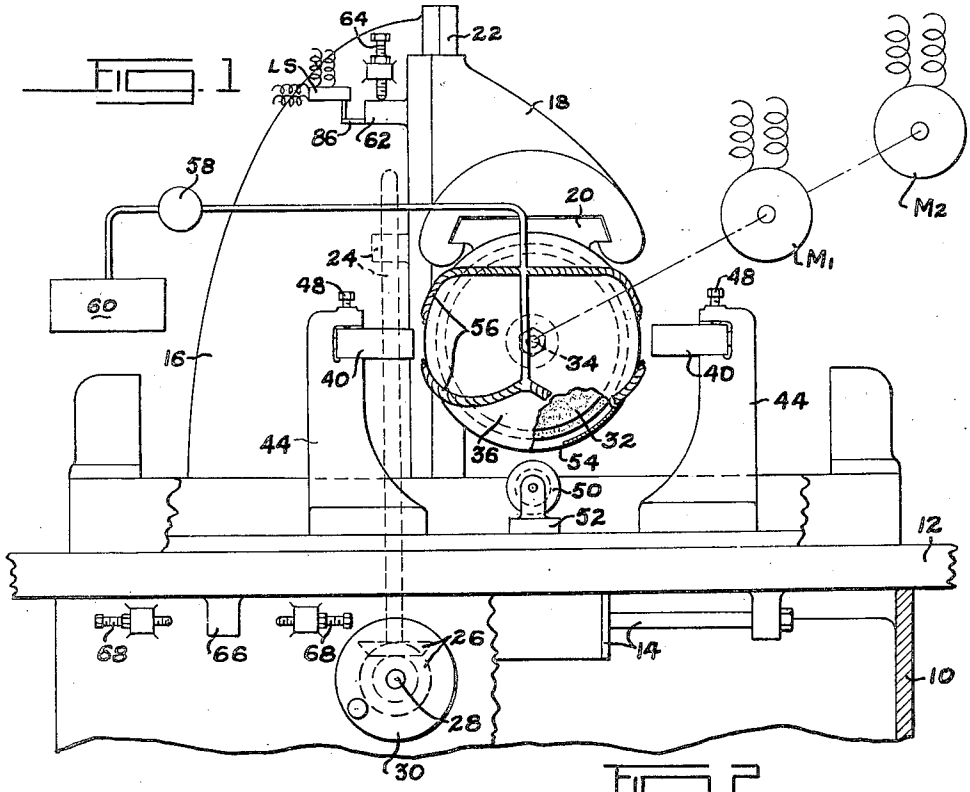


FIG. 3

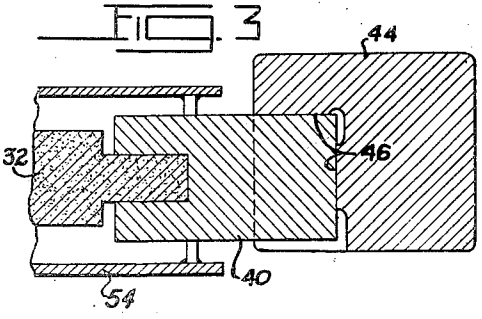


FIG. 2

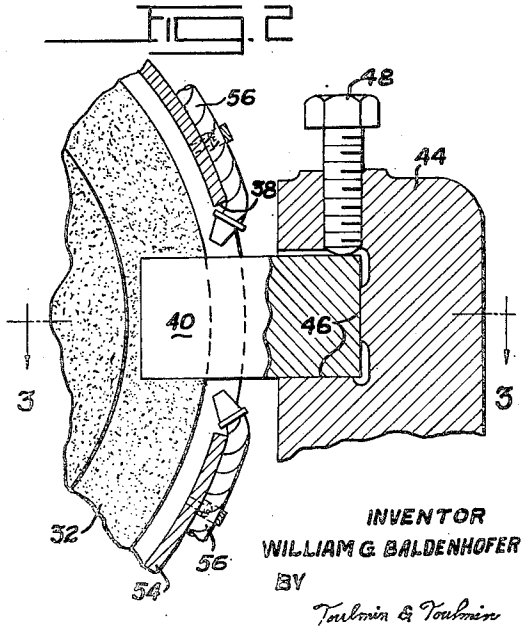
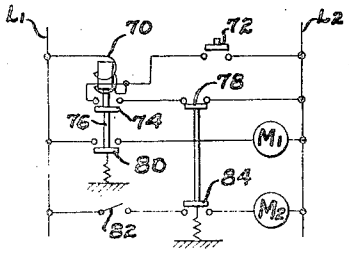


FIG. 4



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METHOD AND APPARATUS FOR GRINDING

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4 Claims. (Cl. 51—98)

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This invention relates to methods and apparatus for grinding workpieces, and particularly to such methods and apparatus in connection with the forming of workpieces having complex convolutions or relative deep slots therein.

Workpieces having complex configurations or deep slots are often encountered in industry and comprise such elements as die segments and the like. Such work members may be formed to a high degree of accuracy and it is customary for the final operation on such articles to be carried out on a grinding machine.

The usual manner of forming such members is to mount them in a suitable fixture on the table of a grinding machine and to traverse them beneath a properly formed grinding wheel. The wheel in such case is formed by any suitable dressing device and preferably is shaped by a crush dressing roller according to modern and well known practices.

The disadvantage with a grinding operation of this type is that a long traverse past the wheel must be made even for very short workpieces in order to grind the slot or configuration of the workpiece from side to side. As an example, considering a workpiece, say, an inch across and which is to have a one-half inch deep slot ground therein by a 12 inch wheel, a total table traverse relative to the wheel of about 7 inches is required. This not only appreciably lengthens the grinding cycle, but the physical arrangement of the wheel and workpiece is such that it is difficult properly to supply cooling fluid to the wheel.

The primary object of the present invention is to provide a method and apparatus for grinding workpieces of the type referred to above and in which the foregoing difficulties are eliminated.

Another object is to provide a method and apparatus for grinding slotted workpieces and the like such that the speed of the grinding cycle is greatly increased.

A still further object of this invention is the provision of a method and apparatus for grinding slotted workpieces and the like wherein the amount of relative movement between the wheel and workpiece is reduced to a minimum thereby requiring the shortest possible time to accomplish the grinding operation.

It is also an object of this invention to provide an arrangement for grinding slotted workpieces and similar work members wherein the coolant supply to the wheel is directed as near to the point of contact of the wheel with the workpiece as is possible.

These and other objects and advantages will

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become more apparent upon reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a side view of a typical grinding wheel arrangement according to this invention and adapted for practicing the methods of this invention;

Figure 2 is an enlarged fragmentary view showing the wheel in grinding engagement with one of the workpieces on which it operates;

Figure 3 is a plan section taken on the line 3—3 of Figure 2; and

Figure 4 is a diagrammatic view showing one form of electrical control circuit for controlling the machine of this invention.

Referring to the drawings, the machine shown therein comprises a bed 10 on which is slidably mounted a table 12. The table may be powered in reciprocatory movement on the bed by any suitable means such as by the hydraulic motor indicated at 14.

Mounted adjacent to or connected with the bed 10 is a column 16 and mounted on the column for vertical reciprocating movements is a saddle 18 which carries a wheel head structure 20 which may be movable in the saddle in a horizontal direction.

The saddle 18 is slidable on the guideways 22 on the column and is movable in the vertical direction by a nut and screw arrangement indicated at 24. The screw is preferably journaled in the column in any suitable manner and is arranged for being driven through the bevel gears 26 by a horizontal shaft 28 and hand wheel 30 connected therewith.

Mounted in the wheel head 20 is a grinding wheel 32 which is secured to the end of a shaft 34 rotatable in a horizontal plane. The shaft 34 has connected therewith a main drive motor M1 which is operable when energized to drive the wheel at grinding speeds and also associated with the said shaft is an auxiliary motor M2 energizable for driving the wheel at dressing speeds. As an example of these speeds, a typical grinding speed has a surface speed of approximately 6,000 feet a minute for the wheel while the crushing speed is a matter of from 200 to 400 feet per minute. It is understood that these motors could be arranged for driving the shaft 34 in any suitable manner and there could be clutch means and the like for selectively connecting them with the shaft if so desired.

The wheel 32 is enclosed in any suitable shield as, for example, the drum-like shield 36 indicated in the drawings. This shield is apertured on both

sides on a level with the shaft 34 as at 38 in Figure 2 and thus provides access to the wheel for the workpieces 40 which are mounted on either side of the wheel in spaced relationship therewith and coplanar in a horizontal plane with the axis of the shaft 34. These workpieces may be supported in any suitable sort of fixture, and for the purpose of illustration there are shown the relatively simple standards 44 which, as is best seen in Figures 2 and 3, comprise the machined flat areas 46 for locating the workpiece and a clamping screw 48 which can be tightened down on the workpiece when properly positioned and rigidly retain it in the fixture.

These fixtures are mounted on the bed 12 in any suitable manner and are spaced apart so that the wheel and shield can be freely moved vertically therebetween. The purpose for moving the wheel and shield vertically is to bring the wheel into engagement with a crushing roller 50 which is journaled in a fixture 52 mounted on the table 12 midway between the fixtures 44. To provide access to the wheel for the crushing roller the wheel shield is apertured at the bottom as indicated at 54 in Figure 1.

Coolant is supplied to the wheel where it engages each of the workpieces by the flexible conduits 56 which are connected together and with the outlet of the coolant pump 58 which draws coolant from a reservoir 60. It will be apparent that the supply of coolant from these conduits is also effective for bathing the wheel during its dressing cycle due to the fact that all of the conduits direct their jets against the wheel at a level substantially higher than the said crushing roll.

In order properly to position the saddle and wheel in the vertical direction when the wheel is retracted from the crushing roller following a dressing cycle, the saddle may have a stop 62 mounted thereon and which abuts an adjustable stop screw 64 carried on the column 16. This provides for positive alignment of the wheel with the workpieces during all grinding operations.

The movement of the table 12 may similarly be limited by a stop member 66 thereon which is adapted on each of its directions of movement to abut one of the adjustable stop screws 68 which are carried on the bed 10. As will be seen hereinafter this provides a limit for the depth of cut which the grinding wheel will take in the workpieces.

The motor M1 and M2 are adapted for being controlled by the control circuit indicated in Figure 4. In Figure 4 there are the power lines L1 and L2 and therebetween is connected a contactor coil 70 which is in series with a normally open push button 72. Bypassing the push button 72 are the normally open blades 74 of the armature 76 associated with the coil 70 and serially arranged with the blades 74 is the blade 78 of a limit switch LS. The armature 76 also has normally open blade 80 in series between the power lines L1 and L2 with the motor M1. The motor M2 is also connected between the power lines L1 and L2 and in series with a manually operated switch 82 and the blades 84 also associated with the limit switch LS.

Operation

In operation, the parts of the grinding machine may occupy the position shown in Figure 1. At this time the limit switch LS is engaged by the part 86 of the column 18 so that the blade 78 thereof is closed and the blade 84 is open. At this time the motor M1 can be energized by closing the switch 72 which energizes the coil 70 to move the armature thereof upwardly thus closing the blades 74 and 80. The blades 74 provide a holding circuit for the said coil while the other of the blades at 80 complete the energizing circuit for the motor M1. The wheel is thus driven at grinding speeds.

In order to grind the workpiece 40 mounted in the fixture 44 the table 12 is moved first in one direction to move one of the workpieces radially inwardly toward the wheel and thereafter is reversed to move the other of the workpieces radially inwardly toward the wheel. It will be observed that the grinding operation on each of the workpieces takes place by a straight radial feeding movement of the wheel into the workpiece. The arc of contact of the wheel with the workpiece is thus quite small and relatively heavy feeds can be taken. At the same time the jets issuing from the flexible conduits 56 impinge on the wheel directly at its area of contact with the workpiece and insure an adequate supply of coolant to the wheel.

The forming of a workpiece by moving it radially relative to the wheel is much more rapid than could be accomplished by mounting the workpiece on the table and traversing it past the wheel therebeneath. A much more rapid overall grinding cycle thus obtains.

As an example of an actual grinding operation workpieces an inch across and having a slot one-half inch deep therein were ground on a machine according to former practices. That is, the workpieces were mounted on the table of the machine and traversed beneath the wheel. These same workpieces were also mounted in fixtures as indicated at 44 and ground by moving them radially into the wheel. The production of workpieces by the method and arrangement of this invention was substantially 14 times more rapid than by former methods. It will be appreciated that this comes about because the wheel has only a one-half inch feeding stroke to make into the workpiece when arranged according to the present invention, whereas a stroke of seven inches of the table is necessary when the workpiece is traversed beneath the wheel.

After a predetermined number of grinding operations during which the table is alternately moved first in one direction and then in the other and during which time the finished workpiece is replaced by an unground workpiece while the wheel is operating on the other thereof, it becomes necessary to reform the wheel to a true shape. At this time the wheel is centered over the roll 50 and then is moved downwardly by manipulation of the hand wheel 36. As soon as the wheel and saddle commence to move downwardly the member 66 will permit the switch LS to move so that the blade 78 thereof opens thus de-energizing the coil 70 and the blade 84 thereof closes thus preparing the circuit for the motor M2. De-energization of the coil 70 drops the armature 76 and permits the blades 80 thereof to open and to de-energize the motor M1.

After the wheel and roll have been brought together the switch 82 is closed to energize the motor M2 which drives the wheel and roll at crushing speed to carry out a dressing cycle. After the dressing operation is completed the hand wheel 36 is moved in the opposite direction and the saddle and wheel head are raised vertically until the stop member 62 is abutted by the screw 64. At this time the member 68 actuates the switch LS whereupon the blade 84 thereof is

opened and the blade 78 is closed. This de-energizes the motor M2 and prepares the control circuit for the motor M1 which can then be energized by closing the switch 72.

It will be apparent from the foregoing discussion of the operation of this machine that a grinding operation according to this invention is very simple and rapid to carry out, merely requiring that the table be reciprocated between two predetermined limits while ground workpieces are continuously replaced by unground pieces.

It will also be noted that whenever the wheel is dressed, and which may occur after each grinding operation or after any given number of grinding operations, means are provided which prevents the wheel from being moved against the dressing roll while the said wheel is driven at grinding speed. This prevents damage to the roll by careless or unskilled operation of the machine.

At the same time, the returning of the wheel to grinding position following a dressing operation on the said wheel is accompanied by an automatic de-energization of the auxiliary motor which drives the wheel at crushing speed whereby the motor for driving it at grinding speed can be energized without the possibility of damaging the auxiliary motor.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. A grinding machine comprising, a support, a rotatably mounted grinding wheel of given diameter secured on said support and vertically reciprocable thereon and having a peripheral work surface, a table positioned on said support below and in spaced relation to said grinding wheel and extending transversely thereto, said table including means for horizontally reciprocating said table on said support, first and second work mounts for workpieces secured on said table one on each side radially of said grinding wheel, said work mounts inclusive of workpieces mounted thereon defining therebetween a spacing greater than said given diameter of said grinding wheel, said work mounts being adapted for the positioning of workpieces thereon in true radial disposition to the work surface of said grinding wheel and being movable radially relatively to said grinding wheel with said table for alternately engaging the work pieces with said wheel, a rotatable crush forming roll secured on said table co-planar with said grinding wheel and interposed midway between said work mounts and having the work surface thereof in true radial disposition relative to said grinding wheel for engagement therewith in planar movement, and means on said support for driving said grinding wheel at grinding speed.

2. A grinding machine comprising, a support, a rotatably mounted grinding wheel of given diameter secured on said support and vertically reciprocable thereon and having a peripheral work surface, a table positioned on said support below said grinding wheel and extending transversely thereto, said table including means for horizontally reciprocating said table on said support, first and second work mounts for workpieces secured on said table one on each side radially of said grinding wheel, said work mounts inclusive of workpieces mounted thereon defining therebetween a spacing greater than said given diameter of said grinding wheel, said work mounts being adapted for the positioning of workpieces thereon in true radial disposition to the work surface of said grinding wheel and being movable radially relatively to said grinding wheel with said table for alternately engaging the workpieces with said wheel, a crush forming roll secured on said table co-planar with and beneath said grinding wheel and interposed midway between said work mounts and having the work surface thereof in true radial disposition relative to said grinding wheel for engagement therewith in planar movement, and means including drive means on said support for selectively driving said grinding wheel at grinding speed and a speed less than said grinding speed.

3. A grinding machine comprising, a support including a bed and a column extending vertically therefrom, a rotatably mounted grinding wheel of given diameter secured on said column and vertically reciprocable thereon and having a peripheral work surface, said grinding wheel being rotatable on an axis on said column, a table positioned on said bed in spaced relation to said grinding wheel, said table including means for horizontally reciprocating said table on said bed, a first motor for driving said wheel at grinding speed, a second motor for driving said wheel at crushing speed, first and second work mounts for workpieces secured on said table one on each side radially of said grinding wheel, work mounts inclusive of said workpieces mounted thereon defining therebetween a spacing greater than said given diameter of said grinding wheel, said work mounts being adapted for the positioning of workpieces thereon in true radial disposition to the work surface of said grinding wheel and being movable radially relatively to said grinding wheel with said table in reciprocation for alternately engaging the workpieces with said wheel, a crush forming roll secured on said table co-planar with and beneath said grinding wheel and interposed midway between said work mounts and having the work surface thereof in true radial disposition relative to said grinding wheel for engagement therewith in planar movement, means including electric switching means on said column responsive to vertical movement of said grinding wheel towards said crush roll for open circuiting said first motor, and means including a switch for energizing said second motor.

4. A method of grinding workpieces which comprises the steps of: fixedly mounting on a reciprocable bed in opposed relation and at a given spacing therebetween a pair of workpieces to be ground, establishing true radial disposition between each of said workpieces to be ground and a circular grinding wheel of predetermined configuration and of lesser diameter than said given spacing, said grinding wheel being interposed between said workpieces, moving one of said workpieces radially into engagement with said grinding wheel while maintaining said spacing, grinding said one workpiece, moving the other of said workpieces radially into engagement with said grinding wheel while maintaining said spacing between said workpieces, grinding said other workpiece, and moving said grinding wheel into contact with a crush roll mounted midway between said workpieces while simultaneously disengaging said wheel from either of said workpieces, and rotating said grinding wheel

at crushing speed while in contact with said crush roll.

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