Aug. 12, 1947. R. C. PRUITT ET AL 2,425,640

SURFACE FINISHING

Filed April 23, 1945 3 Sheets-Sheet 1

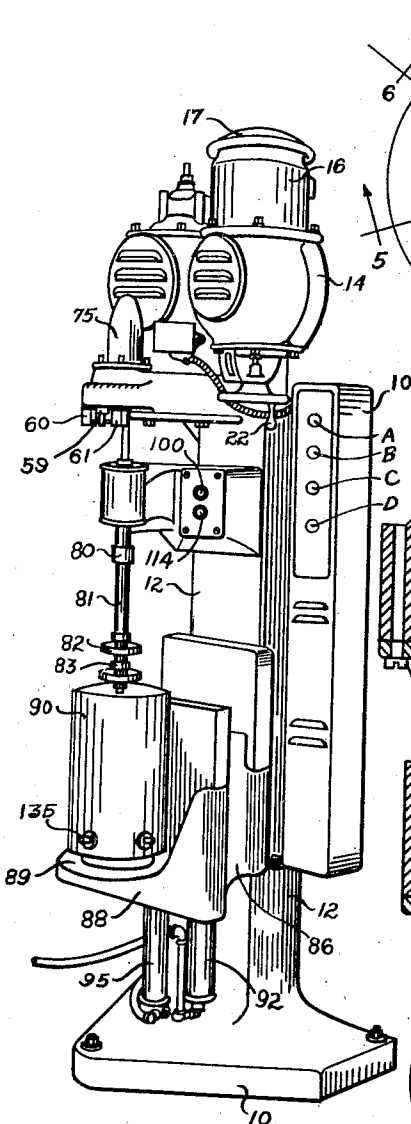

Fig.-1.

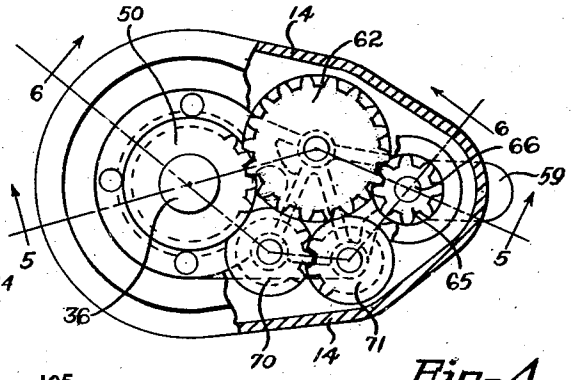

Fig.-4.

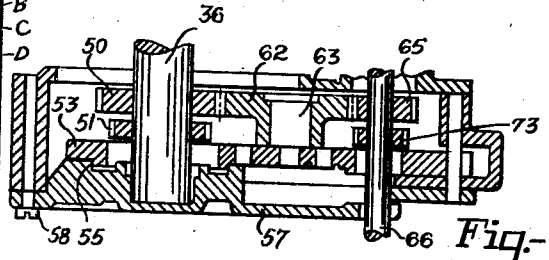

Fig.-5.

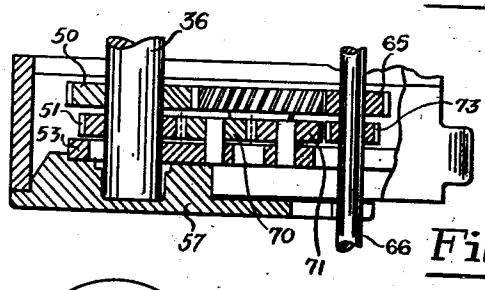

Fig.-6.

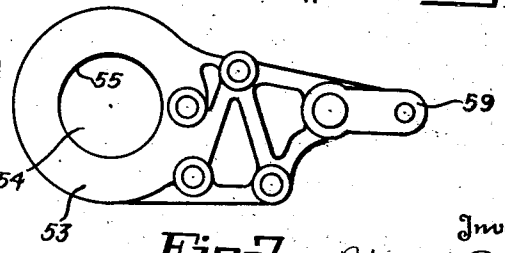

Fig.-7.

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Filed April 23, 1945 3 Sheets-Sheet 2

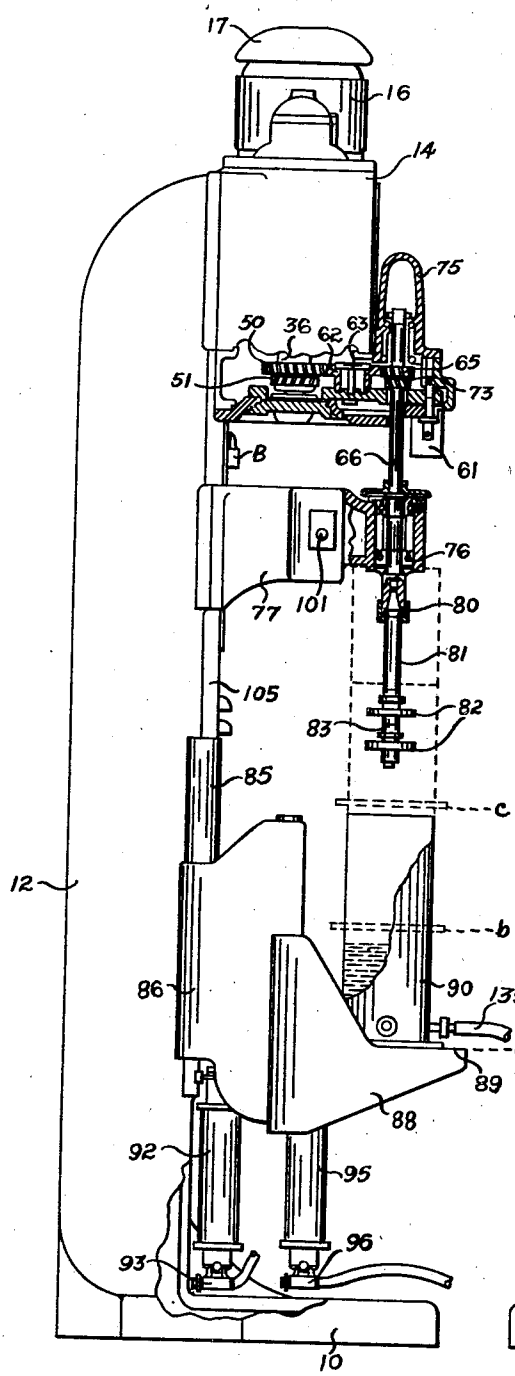

Fig.-2.

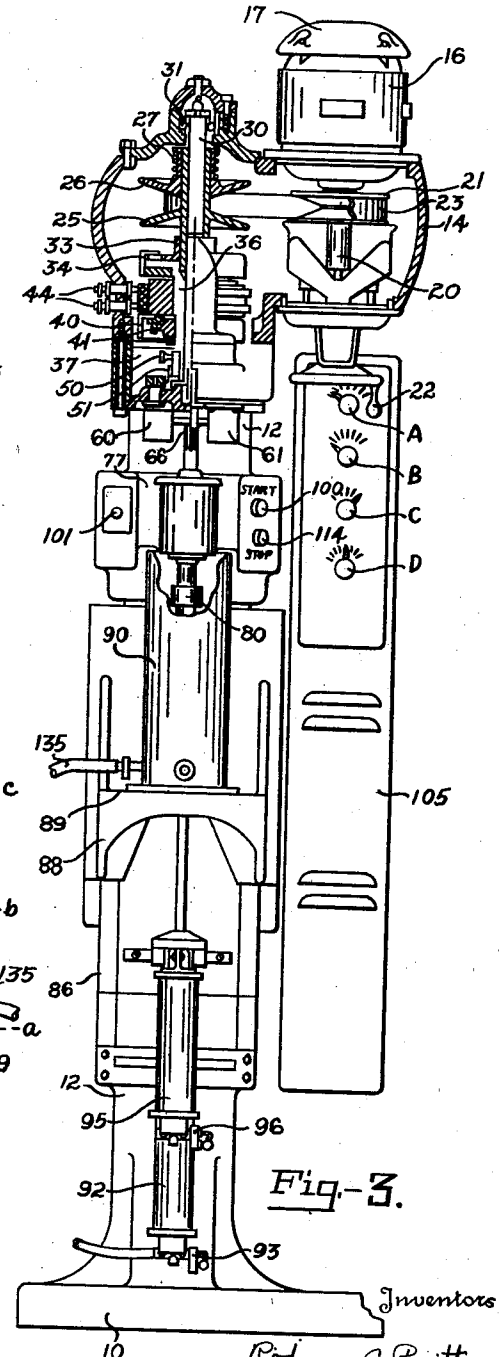

Fig.-3.

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Aug. 12, 1947. R. C. PRUITT ET AL 2,425,640

SURFACE FINISHING

Filed April 23, 1945 3 Sheets-Sheet 3

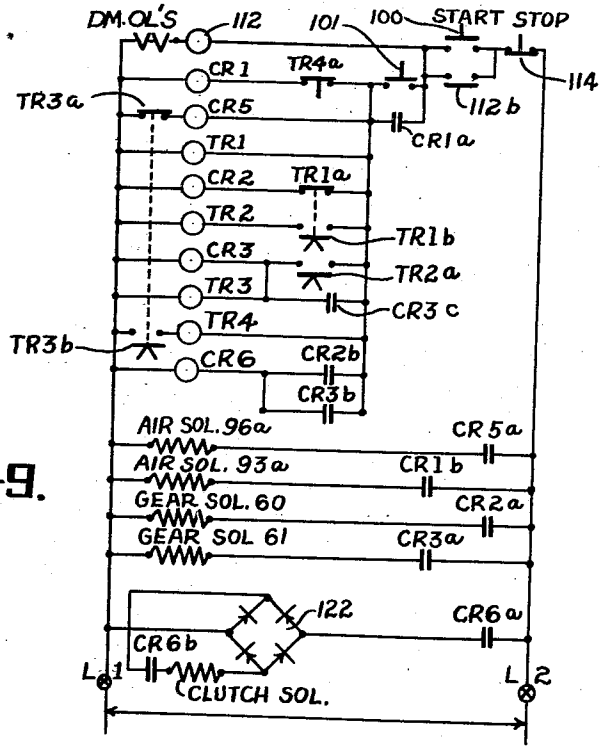
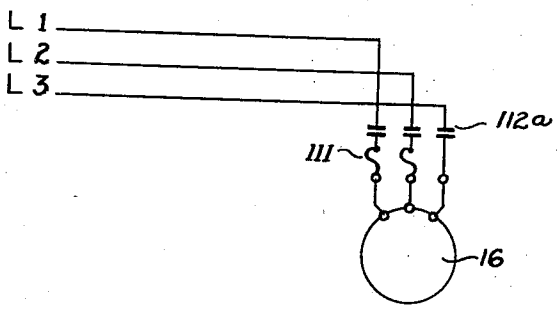


Fig.-9.



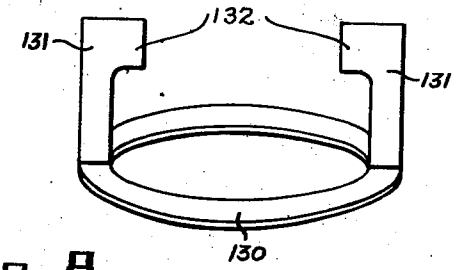


Fig.-8.

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UNITED STATES PATENT OFFICE

2,425,640

SURFACE FINISHING

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Application April 23, 1945, Serial No. 589,786

12 Claims. (Cl. 51—7)

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This invention relates to the smoothing of the sharp edges or surfaces of articles such as gears and the like.

It is the principal object of this invention to provide a simple, rapid and accurately controllable method of removing the burr or wire edge, or of smoothing or breaking the surface of metal, plastic or other articles such as gears and the like to provide a smooth, uniform surface thereon.

It is also an object to provide a machine for accomplishing such burring, breaking, or smoothing which is rapid in its action, relatively simple and easy to operate, and which produces consistent and uniform results.

It is also an object to provide such a machine which can be readily controlled to produce the desired removal of the burr, wire edge, or the like, but without removing other material from the face of the article or otherwise impairing the desired surface thereof.

It is also an object to provide such a machine in which the action can be readily controlled and predetermined through suitable selection of the several variable factors present to develop the desired action in predetermined selected areas, leaving other portions of the metal piece substantially unaffected.

Other objects and advantages will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawing—

Fig. 1 is a view in perspective of a machine constructed in accordance with the present invention;

Fig. 2 is a side elevational view of such machine with certain of the drive mechanism being shown in section and with the pot or tank being shown in three (3) different elevated positions;

Fig. 3 is a front elevational view of the machine also showing certain portions thereof in section;

Fig. 4 is a plan view looking down upon the machine with part of the housing being broken away showing the arrangement of the reversing drive mechanism;

Fig. 5 is a vertical section view on the broken line 5—5 of Fig. 4 showing the gear train for one direction of rotation;

Fig. 6 is a vertical sectional view on the broken line 6—6 of Fig. 4 showing the gear train for the opposite direction of rotation;

Fig. 7 is a plan view of the reversing plate for selecting one or the other of the two gear trains;

Fig. 8 is a detailed perspective view of a removable baffle member which may be introduced into the tank in order to provide additional control over the burring action; and

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Fig. 9 is a circuit diagram providing for the automatic control of the machine.

In many machine operations the work piece when formed on the machine is left with burrs, a wire edge, or with a sharp edge, any or all of which are usually undesirable and which must therefore be removed before the piece is in condition for ultimate assembly and use. This occurs commonly in the production of gears, the customary milling operation for forming the gear teeth usually leaving an objectionable burr along the edge of the teeth, often extending into the bottom of the space between the the teeth. This is particularly objectionable in the production of gears and the like from extremely hard metal, in which case it becomes necessary to process all such articles subsequent to their actual cutting in order to remove such burr, wire edge, or the like. For precision work this operation frequently is done by hand, with a skilled operator using a burring tool against both upper and lower edges of the formed teeth, an operation which it will be understood is one requiring a high degree of skill, and involving a considerable period of time, usually much greater than the time required in the initial cutting of the teeth, and thus materially increasing the cost of the finished article.

In accordance with this invention a machine is provided which rapidly and accurately performs such burring and smoothing operations under controlled conditions which provide a high degree of initial accuracy as to the extent of the burring which is effected, and likewise which can be carried out with great uniformity so that a series of articles may be finished in a substantially identical manner. The possibility of variations occurring in any one article, and between a series of articles, is thus largely overcome, as is likewise the need for a highly skilled worker to perform such an operation. The machine itself provides for uniformity and properly controlled smoothing and burring, and is so constructed that it may be readily operated in an entirely satisfactory manner by an unskilled worker.

In addition to the elimination of the individual skill of the workman, the machine provides for smoothing the edges of all the teeth, both upper and lower edges, at the same time, and further may conveniently be constructed to provide for the treating of a group of articles simultaneously. Furthermore the entire operation for smoothing

or burring the group of articles requires only a small fraction of the time usually required for performing a hand operation upon one such article.

Referring to the drawing which discloses a preferred embodiment of the invention, the machine is shown as comprising a base 10 which may rest upon a floor, and an upwardly extending main frame 12. A head 14 is supported on the upper end of the frame 12 and is formed with an enclosing housing in order to provide protection for the operating mechanism housed within.

Mounted at one side of the housing 14 is the drive motor 16 to the upper end of which is secured a protective umbrella 17. The motor stands with its axis vertical and has a drive shaft 20 which extends downwardly into the housing, and on which there is mounted the adjustable pulley 21 forming the driving element of a variable ratio drive. For purposes of illustration the Reeves type of drive is illustrated, incorporating a hand wheel 22 which may be manually adjusted to change the spacing between the two sheaves of the drive pulley 21, between which there is received the V-belt 23.

The driven member comprises a fixed sheave 25 and a movable sheave 26 which is resiliently urged by spring 27 toward the fixed sheave. The two sheaves are arranged to drive a vertically extending shaft 30 which is suitably journaled in the housing by means of bearing 31. It will be understood that by changing the setting of hand wheel 22, the effective diameters of the driving and driven pulleys will be changed to thus secure a continuously variable speed ratio.

An upper hub 33 is keyed to shaft 30 and an electromagnetic clutch member 34 is provided for clutching engagement and disengagement with hub 33. Upon engagement when energized, the clutch provides for the direct driving of the lower hub 36 which is the main driven shaft and is suitably journaled in the housing and extends downwardly into the gear chamber 37. In addition a resiliently applied friction brake cage 40 is provided which cooperates with the brake element 41 to provide a braking action to stop the rotation of the shaft 36 when disconnected from the drive source and upon deenergization of the clutch solenoid. Satisfactory results have been secured with the use of a special combination style E–E #602–2 Stearns magnetic clutch and brake.

Preferably the clutch 34 and brake 41 are controlled together, contact elements 44 providing for supplying electrical energy through slip rings to provide for the simultaneous energization of both clutch and brake. Upon energization the clutch is engaged, and the brake is released. When deenergized, the clutch springs effect the release of the clutch, thus disconnecting the driven shaft 36 from the drive shaft 30, and the brake is also applied to stop the rotation of shaft 36.

In gear chamber 37 the driven shaft 36 carries an upper drive gear 50 and a lower drive gear 51. These two gears provide separate drives for effecting reversal of rotation of the articles being treated, this mechanism being as follows. A shift plate 53 (see Fig. 7) is provided which has a central opening 54 adapting it to be received around the lower end of driven shaft 36. It also has an annular flanged lower edge 55 which adapts it to be seated in a corresponding groove formed in a bottom plate 57 which is suitably attached by means of bolts 58 to the lower side of housing 14. The flange 55 is formed concentrically with the

axis of shaft 36 and the plate is thus free to oscillate upon its support about shaft 36. It carries an outwardly extending arm 59 which may be manually operated to shift from one position to another. Preferably however a pair of solenoids 60 and 61 are arranged to be selectively actuated to shift the plate between its two positions.

Two sets of drive gears are carried by the plate 53 at different levels. The upper set comprises the gear 62 meshing with gear 50 and mounted on plate 53 by means of an upwardly extending pin 63, and which is adapted to have meshing engagement with a driven pinion 65 fixed to the shaft 66.

The lower set carried on plate 53 includes a pair of gears 70, 71 which are mounted thereon in position to engage the lower drive gear 51, and in turn to be engageable with a driven pinion 73, also fixed to driven shaft 66. The mounting of the two gear trains is such that as shown in Fig. 4 only one set can be in driving relation with shaft 66 at the same time. As shown in that figure, the gear train comprising gear 50, idler pinion 62, and the driven pinion 65 provides for driving shaft 66 in one direction of rotation. At this time the alternate train, including driving gear 51, and the two idler pinions 70 and 71 are rotating freely, pinion 71 being out of mesh with driven pinion 73. When however rotation in the opposite direction is desired, the plate 53 is moved, either manually or automatically with the two gear assemblies thereon in a counter-clockwise direction as shown in Fig. 4, which results in disengaging gears 62 and 65, and establishing driving engagement between gears 71 and 73, thus resulting in driving shaft 66 at the same speed but in the opposite direction.

Shaft 66 is suitably journaled in an auxiliary housing 75 at its upper end, and its lower end is provided with bearings 76 which are received in a bracket 77 supported from the main frame 12 of the machine. The shaft 66 has a coupling 80 at its lower end and provision is thus made for receiving the work support or spindle 81 on which previously have been assembled the work piece consisting of gears or the like 82. As shown they are preferably spaced somewhat from each other by means of suitable collars 83.

The frame 12 of the machine is provided with vertically extending ways 85 which adjustably receive thereon a rear slide 86. Movably mounted on the rear slide 86 is a front slide 88. Such front slide is provided with a platform 89 on which there is detachably secured the pot or tank 90 in such manner that while removable for refilling, it is securely held against movement during use. Preferably it is centered by a non-sticking taper pilot and held by screws extending upwardly into the bottom of the pot.

Means are provided for separately actuating the two slides, such means being shown as an air cylinder 92 controlled by air valve 93 for causing the raising and lowering of the rear slide 86 with respect to the main frame of the machine. Similarly air cylinder 95 controlled by air valve 96 provides for raising and lowering of the front slide 88 relative to rear slide 86. From the above it will be clear that the pot 90 can be moved into two raised positions at different elevations, such elevations being indicated approximately by the designations *a*, *b*, and *c*, respectively in Fig. 2, referring to the position of the bottom of the tank in each case.

Tank 90 is adapted to contain a quantity of abrasive in fluid suspension. Such abrasive may

vary as to its own characteristics and also may be prepared in suspensions of different viscosity and other physical characteristics as desired to bring about the proper results in operation. As an example, highly satisfactory results have been secured where the abrasive consisted of No. 12, No. 20 or No. 30 silicon carbide grits, the No. 20 size having been found to be preferable for most purposes. Such abrasive is mixed with a fluid suspending vehicle which will have sufficient viscosity to suspend the abrasive and such body as to retain the abrasive in working contact with the relatively moving surface of the article as required to work off the burrs and wire edges. Preferably a relatively heavy oil is used as the vehicle, a suitable material for this purpose having been found to be a No. 30 S. A. E. lubricating oil. The mixture is made up preferably to about the consistency of a cooking porridge, 40 pounds of abrasive being thoroughly intermixed in 1 gallon of the vehicle, and sufficient quantity of the suspension is placed in the pot so that when raised to its uppermost position the upper surface of the top gear or article being treated will be submerged in operation to a depth of about one-half to one inch.

In the burring or smoothing of an article in accordance with this invention several operations are usually involved. Where the article is symmetrical in shape, it is found desirable to subject the article to relative movement through the abrasive suspension for a definite period of time in one direction, and then to reverse the direction of motion and to continue in the reverse direction for a similar length of time. This develops a similar action on corresponding surfaces of the article, and by suitable selection of the characteristics of the suspension itself, the fineness and abrasive quality of the suspended abrading material, the closeness of approach of a stationary wall to impede the rotation of the suspension with the article, and the actual time and speed of rotation, it is possible to control and predetermine in large measure the location, characteristics, and extent of the smoothing action which is produced.

The machine may be conveniently controlled manually, or in part manually and in part automatically. It has been found desirable, however, to provide time controls for definitely predetermining the length of time during which the article is rotated while in the abrasive solution, since the continuance of such action for a prolonged period of time may lead to excessive abrading of working portions of the surface of the article, rendering it either damaged or unfit for use. However where a definite time control is provided which will assure the stoppage of the action within a definite and controlled period of time, the possibility of the action being allowed to continue inadvertently for an excessive period of time is largely overcome. In actual practice it is found important to control the time limits quite accurately, as measured in terms of seconds, in order to develop the desired action, and to assure proper uniformity for a series of articles.

If desired the air supply valves for controlling the air supply to cylinders **92** and **95** may be controlled by hand, and likewise the gear shifting and reversing mechanism may be manually operated. In such manual operation, as will be clear from the foregoing, the work spindle **81** receives one or more of the articles to be treated. Both control valves **93** and **96** are then opened to

cause the raising of the pot **90** to a position in which the articles are submerged beneath the surface of the abrasive solution. The start button **100** may then be pressed to close a suitable energizing circuit for the motor. A second start button **101** may be provided for initiating the rotation of the spindle, causing the energizing of the clutch and concurrent release of the brake with resultant driving of the work.

The work shaft is thus caused to rotate, and such operation is continued for a definite period of time after which the clutch is deenergized and the brake applied to stop the spindle. Thereupon the plate **59** may be swung manually to its other alternative position, establishing a driving connection to rotate the work spindle in the opposite direction. Upon subsequent operation of push button **101**, the work spindle then revolves for a predetermined period of time in the opposite direction and is again brought to a stop at the end of that period.

One of the air valves, **95**, may then be closed resulting in the lowering of the pot from the *c* position to the *b* position where the work is above the liquid level but still within the upper rim of the pot. The work is then rotated for a short period of time sufficient to throw off the bulk of the adhering suspension under the action of centrifugal force. The remaining air valve **93** is then closed, and the spindle stopped, whereupon the finished article may be removed and the device is in condition for a subsequent cycle of operation.

Preferably the mechanism is arranged for control over an entire cycle of operations, suitable electrical relays being provided and assembled on the frame of the machine in a housing **105** provided for that purpose. The operation of the system is based upon the use of a group of time-controlled relays (TR1, TR2, TR3 and TR4) which are sequentially energized, and the time intervals of which may be individually controlled (by means of the respective micrometer adjusting dials A, B, C and D) in order to provide complete flexibility of adjustment for all positions of the operating cycle. Any suitable timing devices may be used an example of a suitable type being the Square D Company Class 9050 timing relays.

Referring to Fig. 9 which shows a wiring diagram of the overall control mechanism the main drive motor **16** is shown as energized from a three phase power source **110** through overload fuses **111** and contactors **112***a*. The control circuits are energized from a single phase source of supply as shown at **113**.

For this purpose a normally closed stop button **114** provides a connection to the start button **100**, so that upon depression of the start button, relay **112** is energized, thereby effecting the closing of its contacts **112***a* to close the main circuit to the drive motor. The switch contacts **112***b* are also closed at the same time to establish a holding circuit by-passing the start button **100**, so that the drive motor will remain energized until the operation of stop button **114**.

The drive motor having thus been placed in operation, the articles are properly mounted upon the work spindle **81**. When this has been completed, the operator then presses the start button **101** which places the machine in operation, the operation continuing without further attention on the part of the operator throughout an entire operating cycle.

In response to the operation of the push button **101** to start the cycle, an energizing circuit

is closed through time-controlled relay or timer TR1. Such timer may suitably be a control which remains with its contacts in the normal position for a predetermined adjustable length of time after being energized, and which thereupon operates. An energizing circuit is thus provided for relay CR2 through normally closed controls TR1*a* of this timer. An energizing circuit is also provided for relay CR1 through the normally closed contacts TR4*a* of timer TR4. Timer TR1 thus begins the timing period for the first operation.

Upon actuation relay CR1 closes its contacts CR1*a* which establish a maintaining circuit around push button 101 providing for maintaining itself energized throughout the remainder of the cycle. The same relay has another pair of contacts CR1*b* which are included in the energizing circuit of solenoid 93*a* which controls air valve 93, thereby actuating such solenoid and providing for the opening of air valve 93 to raise the rear slide on the pedestal.

A circuit is also closed through relay CR5 and the normally closed contacts TR3*a* of timer TR3, the contacts CR5*a* of which relay thus close at once to establish an energizing circuit for solenoid 96*a* which upon actuation provides for the opening of air valve 96 to raise the front slide on the rear slide.

Relay CR2 upon actuation closes its contacts CR2*a* which are included in the circuit of gear solenoid 60, thus providing for the shifting of the gear plate 53 to establish a drive in one direction for the work spindle.

Another pair of contacts CR2*b* of relay CR2 are included in the energizing circuit of relay CR6, which also closes almost immediately, such relay having contacts CR6*a* in the primary and CR6*b* in the secondary circuits of a rectifier 122 so that direct current power is thereupon supplied to the circuit for the clutch 34 and brake 41 as described above to effect release of the brake and engagement of the clutch.

It will thus be clear that immediately upon depression of start button 101, the pot is raised to its full height through the operation of the two air solenoids, the gear train is established for driving the spindle in one direction of rotation, and the brake is released and the clutch is engaged with the already operating drive motor, to thus transmit rotary motion to the work spindle which now supports the work in position immersed within the abrasive suspension.

This operation continues for the predetermined period of time as determined by the setting of the dial A (Fig. 3) of timer TR1, that being the length of time desired for the treatment of the articles in the abrasive solution. At the end of this time interval, timer TR1 is operated and its normally closed contacts TR1*a* which are in circuit with relay CR2 are opened and relay CR2 is thus deenergized, and its contacts CR2*a* and CR2*b* are opened. This effects deenergization of gear solenoid 60 and also deenergizes relay CR6 opening contacts CR6*a* and CR6*b* so that the energization of the clutch is cut off, and the brake 41 is applied while the clutch 34 is disengaged.

The normally open contacts TR1*b* of timer TR1 are also closed at the same time and this establishes an energizing circuit for timer TR2. Dial B (Fig. 3) of timer TR2 is adjusted for a short interval, long enough to allow the spindle to come to a complete stop. At the end of that time, timer TR2 closes its normally opened contact TR2*a* which thus establishes an energizing circuit for relay CR3 and timer TR3.

Relay CR3 has one set of contacts CR3*a* in the energizing circuit of solenoid 61, so that upon closing, the shiftable plate 53 is moved to its alternative position to thus establish a drive for the work spindle in the opposite direction from the previous driving. Another set of contacts CR3*b* of relay CR3 is in the energizing circuit of relay CR6 which is thus re-energized, to establish direct current power for engaging the clutch and releasing the friction brake. The work spindle is thus caused to rotate at the same speed as before, but in the opposite direction, maintaining the work submerged within the abrasive solution. Relay CR3 has a third set of contacts CR3*c* which provide a safeguarding maintaining circuit.

This reverse rotation continues for the length of time as determined by the adjustment of the dial C (Fig. 3) of timer TR3, which may be either the same as or different from that provided by timer TR1. At the end of that interval timer TR3 opens its normally closed contact TR3*a* in the energizing circuit of relay CR5 and closes its normally opened contact TR3*b* in the circuit of timer TR4.

The deenergizing of relay CR5 results in the opening of its contacts CR5*a* in the circuit to air solenoid 96*a*, air valve 96 thereupon closing to cause the partial lowering of the pot to the *b* position. Meanwhile the rotation of the spindle has continued, and the work is thus withdrawn from the abrasive solution and is being spun above the liquid level below the upper edge of the pot. This is allowed to continue for a period of time sufficient to produce an effective cleaning of the abrasive solution from the surface of the articles under the action of centrifugal force, and is suitably adjusted in accordance with the setting of the dial D (Fig. 3) of timer TR4.

At the end of such time interval, relay TR4 is energized and its normally closed contacts TR4*a* in the circuit of relay CR1 are opened. As soon as this occurs the energizing circuit of all the relays is opened at the contacts CR1*a*, and the cycle is thus ended, air solenoid 93*a* being likewise deenergized with resultant closing of air valve 93 producing the final lowering of the pot to the position where it is clear of the articles which may then be removed from the stationary spindle. A new group of atricles may then be secured to the spindle and the cycle may then again be started and will continue in the same sequence without further attention on the part of the operator.

It has been found that satisfactory results are secured with a range of speeds of the work supporting spindle from about 2,000 to about 6,000 R. P. M. Gears have been successfully handled having pitch diameters ranging from approximately 1 inch to 6 inches, and from 4 to 24 diametral pitch. For this range four pots have been provided with inside diameters of 4, 5, 6½ and 8 inches respectively. It has usually been found that the inside diameter of the pot should be within about 1 or 2 inches of the diameter of the gear or article to be burned, and for that reason a series of different size pots may be provided. Alternatively, an auxiliary baffle member 130 may be provided in the form of a cylindrical tube, or may be provided with upwardly extending baffle arms 131 (see Fig. 8). The baffle is adapted to be removably received in fixed rela-

tion within one of the larger diameter pots and functions to control the rotation of the suspension therein, in place of using a smaller diameter pot. Where it is desired to treat a gear cluster including gears or surfaces of relatively large and small diameter axially spaced from each other, the use of a baffle such as shown in Fig. 8 is particularly advantageous. As shown the arms may be suitably shaped to provide inwardly extending projections 132 to afford desired clearance with respect to an upper smaller diameter gear as well as with respect to a lower larger diameter gear, the arms being suitably shaped in each instance to provide the desired clearance with respect to all portions of the article under treatment.

Using the suspension medium above described and in the treating of precision gears of a hardness of about 38 Rockwell C, speeds of 3,000 to 3,500 R. P. M. have been successfully used with a time interval in each direction of 10 to 15 seconds, the uppermost gear or article under treatment being covered while in the pot to a depth of about ½ to 1 inch. Work of different hardness and grain structure has been found to require suspensions of different kinds and grades of grit or abrasive, and the foregoing are mentioned only as examples which have given satisfactory results.

If desired agitation may be provided in the pot, this being suitably effected by the supplying of compressed air to the bottom part thereof as shown at 135, in order to maintain the solution well mixed. Such agitation is also advantageous in that it reduces the strain on the supporting arbor, and somewhat reduces the starting torque required to start the rotation of the spindle.

The invention thus provides a simple and highly reliable machine for effecting uniformly and rapidly what has heretofore required long drawn out individual work to perform at all, and which could not be done under conditions assuring a high degree of uniformity. By suitably varying the character and consistency of the material in the tank, the time during which the operation continues, and the closeness of approach of the stationary parts of the pot to the article being treated, substantially complete and accurate control can be secured over both the extent of the smoothing and burring operation, as well as over the particular parts or area in which that action is made effective. Careful tests have shown that when controlled in this manner the burr can be completely removed from around the edge of the teeth of a series of gears mounted on the work spindle, while the working faces of the teeth are left almost completely without change, the suspension appearing to contact the edges of the teeth but primarily remaining out of working contact with the actual face of the teeth due to the centrifugal forces involved. As will be clear, the rotation at higher speeds provides for increasing such centrifugal effect, and thus in conjunction with the other factors above described makes it possible to obtain proper predetermined action over the article as desired.

While the processes and forms of apparatus herein described constitute preferred embodiments of the invention it is to be understood that the invention is not limited to these precise processes and forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in fluid suspension, a support having means thereon for receiving the article, means for moving said support with said article attached thereto relative to said fluid suspension for a period of time sufficient to effect the smoothing and burr removal therefrom, and a baffle removably positioned in said container and projecting upwardly in predetermined relation to said article.

2. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in fluid suspension, a support having means thereon for receiving the article, means for rotating said support with said article attached thereto in said fluid suspension for a period of time sufficient to effect the smoothing and burr removal therefrom, and removable means receivable in said container in predetermined operative relation with said article and constructed to limit the movement of a fluid in said container with respect to the container.

3. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in thick fluid suspension, the inner vertical dimension of said container being substantially greater than the vertical dimension of the article to be treated, the quantity of suspension in said container being controlled to a depth sufficient to receive said article therein while leaving space within the container and above the level of the suspension sufficient to receive said article therein, a support having means thereon for receiving the article, means for moving said container relative to said support to immerse the article in said suspension, means for rotating said support with said article attached thereto in said suspension, and means for moving said container relative to said support to cause withdrawal of the article from said suspension while remaining within the confines of said container to provide for the throwing off of said suspension material from the article under the action of centrifugal force and for the retention of said material within said container.

4. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in thick fluid suspension, the inner vertical dimension of said container being substantially greater than the vertical dimension of the article to be treated, the quantity of suspension in said container being controlled to a depth sufficient to receive said article therein while leaving space within the container and above the level of the suspension sufficient to receive said article therein, a support having means thereon for receiving the article, means for moving said container relative to said support to immerse the article in said suspension, means for rotating said support with said article attached thereto in said suspension, and means to withdraw the article from the suspension and from said container in a plurality of stages including a first stage in which the article rotates within the confines of the container above the level of the suspension to throw off said suspension material against the inner walls of the container, and a second stage in which the article is clear of the container.

5. A machine for smoothing and removing

burrs and the like from an article which comprises a container for receiving a quantity of abrasive in fluid suspension, a support having means thereon for detachably receiving the article, means for rotating said support with said article attached thereto in said fluid suspension for a period of time sufficient to effect the smoothing and burr removal therefrom, means for reversing the direction of rotation of said support, and means for controlling the length of time of rotation of said article in said suspension in both directions of rotation.

6. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in thick fluid suspension, a support having means thereon for receiving the article, means for raising the container to immerse the article within said suspension, means for rotating said article while immersed in said suspension, and control means for correlating the rotation of said article with the raising of said container providing for the beginning of such rotation concurrently with the raising of the container.

7. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in fluid suspension, the inner vertical dimension of said container being substantially greater than the vertical dimension of the article to be treated, the quantity of suspension in said container being controlled to a depth sufficient to receive said article therein while leaving space within the container and above the level of the suspension sufficient to receive said article therein, a support having means thereon for receiving the article, means for raising the container to immerse the article within the suspension, means for rotating said article while immersed in abrasive smoothing contact with said suspension, means for lowering said container to withdraw the article from said suspension while leaving the same within the confines of the upper wall of said container, and means for rotating said article for a predetermined period after withdrawal from said suspension to provide for the throwing off of said suspension material from said article under the action of centrifugal force and for the retention of said material within said container.

8. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in fluid suspension, the inner vertical dimension of said container being substantially greater than the vertical dimension of the article to be treated, the quantity of suspension in said container being controlled to a depth sufficient to receive said article therein while leaving space within the container and above the level of the suspension sufficient to receive said article therein, a support having means thereon for receiving the article, means for raising the container to immerse the article within the suspension, means for rotating said article while immersed in abrasive smoothing contact with said suspension, means for lowering said container to withdraw the article from said suspension while leaving the same within the confines of the upper wall of said container, means for rotating said article for a predetermined period after withdrawal from said suspension to provide for the throwing off of said suspension material from said article under the action of centrifugal force and for the retention of said material within said container, and

means to thereafter return the container to its fully lowered position leaving the article clear thereof for removal.

9. A machine for smoothing and removing burrs and the like from an article which comprises a container for receiving a quantity of abrasive in fluid suspension, a support having means thereon for detachably receiving the article, means for raising the container to immerse the article within said suspension, means for rotating said article while immersed in said suspension, control means for correlating the rotation of said article with the movement of said container providing for the beginning of such rotation concurrently with the raising of the container, means for timing the period of rotation of the article while immersed to effect removal of rough parts and burrs therefrom without adversely affecting the working surfaces of the article, means for partially lowering the container to remove the article from the liquid while leaving it within the confines of the upper wall of the container, means for rotating said article in said removed position to free the same of said suspension, and means to thereafter return the container to its fully lowered position leaving the article clear thereof for removal from said support.

10. The process of smoothing and removing burrs and the like from a gear wheel which comprises immersing the gear in a relatively thick and viscous suspension of abrasive, rotating said gear at high speed while so immersed for a sufficient time to effect the smoothing and removal of burrs therefrom, and thereafter withdrawing said gear from said suspension and rotating the same at high speed to clean the gear by throwing off therefrom said suspension material.

11. The process of smoothing and removing burrs and the like from a gear wheel which comprises immersing the gear in a relatively thick and viscous suspension of abrasive, rotating said gear about its own axis in one direction while so immersed, then rotating said gear in the opposite direction while so immersed, and controlling the length of rotation in each direction to effect burr removal without abrading the adjacent surfaces of the teeth of said gear.

12. The process of smoothing and removing burrs and the like from a gear wheel which comprises immersing the gear in a relatively thick and viscous suspension of abrasive, rotating the article while so immersed for a sufficient time to effect the smoothing and removal of burrs therefrom, and controlling the time and the speed and direction of rotation to predetermine the smoothing and burring action which is produced and to effect burr removal without abrading the adjacent surfaces of the teeth of said gear.

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