

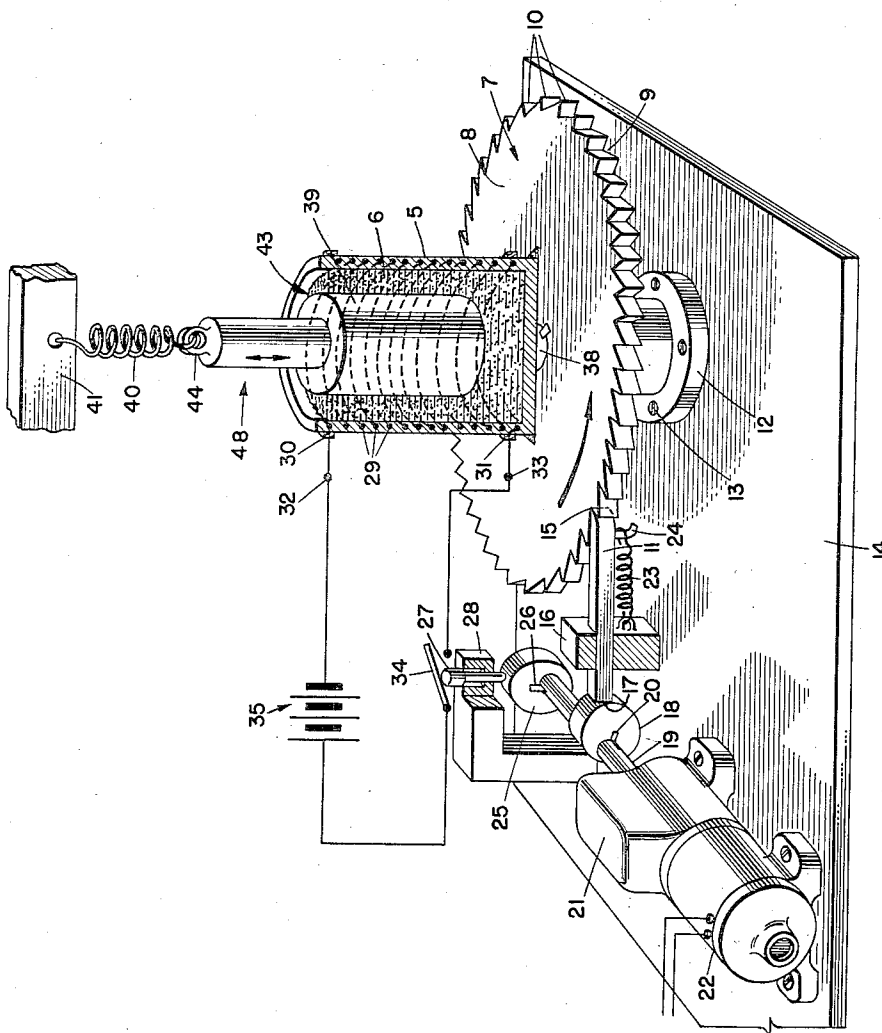
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POLISHING TREATMENT FOR ARTICLE SURFACES

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POLISHING TREATMENT FOR ARTICLE SURFACES

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to polishing treatment for article surfaces and more particularly relates to an apparatus and a method for abrasive-type polishing which is automatic in operation and operates by means of a rotating magnetic fluid which alternately frictionally engages and releases an article to be polished as the article is reciprocated in the magnetic fluid.

Prior art methods of performing the function of the invention include hand and machine polishing by frictionally contacting a surface to be polished with polishing cloths or paper in the case of hand polishing, or with abrasives or polishing wheels in the case of machine polishing. Disadvantages of these methods are the short duration of effectiveness of the polishing clothes or wheels due to the abrasive particles becoming smooth and clogged after repetitious use, and the necessity for close attention of an operator to obtain a polish without marring the surface to be polished. Other disadvantages are the labor time involved, and the total time necessary to achieve the job as well as certain deficiencies in the result of the prior art polishing technique.

Methods of obviating some of these disadvantages have been proposed, for example, in the patent to P. K. A. Cuppers, Patent No. 2,664,676 for Finishing of Workpieces issued January 5, 1954, the work was inserted in a paste of abrasives and then rotated. Other methods attempting to obviate disadvantages of hand and machine polishing include the Method of and Apparatus for Cutting and the Like of A. G. Bodine, Jr., Patent No. 2,460,918, issued February 8, 1949, and a second patent to the same inventor for Method of and Apparatus for Cutting Materials, Patent No. 2,460,919, issued February 8, 1949. In these patents polishing of the surface of an article was made by contact therewith of abrasive particles suspended in an elastic medium by virtue of their movement induced by the drag upon such particles or by molecules of such medium moving in response to sound waves propagated in the medium. These methods tried to overcome deficiencies in hand and machine polishing methods by providing very light impact of the abrasive particles with the surface with very minute amplitude of the movement of the abrasive particles at high rapidity because of the high velocity of such particles in contact with the surface. The above-mentioned Bodine, Jr. patented methods utilized a sound wave generator of the magnetostriction bar type which comprised a metal bar having wrapped therearound a coil of an electrical conductor and mounted to a bracket secured to an end wall of a vessel which contained a fluid and abrasive particles.

Still other prior art methods are illustrated in the patents to H. N. Maier, Patent No. 2,591,083 issued April 1, 1952, for Removal of Flash, Fin, and Burr and

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J. C. Hackett et al., Patent No. 2,554,701 issued May 29, 1951, for Treatment of Articles to Remove Some of the Outside Material Therefrom or to Polish the Same. Both of the latter patents used magnetic means to vibrate mechanical elements to cause abrasive material to impinge at a given rate on metal. In these methods and means diaphragms vibrated the liquid causing contact between the particles inside to remove burrs from the work thereof.

However, all of the above enumerated prior art devices had disadvantages of not preventing damage to the work, the inherent slowness of operation, they were not adaptable to a fine polishing finish as provided by the instant invention, and in addition they did not remove deficiencies of the old hand and machine methods in that the abrasive material tended to become clogged and to present increasingly diminished effectiveness of operation.

The present invention overcomes these and many other defects of the prior art and in addition by the use of the inventive method and apparatus finer polishing is achieved, longer life of abrasive particles is permitted and automatic operation may take place.

Accordingly, an object of the present invention is to provide an abrasive-type polishing apparatus and means which is automatic in operation by means of a magnetic fluid which alternately frictionally engages and releases the article to be polished as the article is reciprocated in the magnetic fluid which fluid is simultaneously rotated.

Another purpose of the invention is to provide apparatus and a method for polishing metallic objects to a high finish wherein the polishing material will have a substantially continuous and longer duration of effectiveness and which will obtain a polish without marring the surface to be polished or without causing appreciable deviation from required size tolerances of the work.

Another aim of the invention is to provide a polishing method and means whereby finer polishing may be achieved, whereby abrasive particles utilized will have a longer life and which is capable of automatic operation.

Another object of the invention is to provide an automatic means and method for providing a highly polished smooth surface on articles of various forms which do not leave objectionable scratches on the polished surfaces and do not scuff, burnish, peen, or overheat the work surface locally.

Another purpose of the inventive device and method is to remove the drawbacks of the conventional finishing methods and to provide effectiveness, automatic operation and abrasive material preservation while performing accurate, reliable, and economical polishing operations.

Still another aim of the instant invention is to provide a new, rapid and relatively inexpensive method and means for polishing a surface such as a metallic surface wherein is provided a rotating vessel in which a magnetic fluid of oil, metal powder, and abrasive particles are immersed, and wherein the intermixed metal powder and abrasive particles are alternately magnetized and demagnetized and with the compound motion resulting from the rotating container are oriented so that different cutting edges or surfaces are presented to the work continuously thereby providing for longer, in fact, practically infinite life of the abrading materials and causing a smoother and quicker operation.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein the figure diagrammatically presents partially in schematic and partially in pictorial representation an illustrative embodiment of a

preferred form of the apparatus of the invention with parts broken away to better show inherent operation of the device, the device being capable of utilizing the inventive method.

Referring more particularly to the figure, a suitable container 5 may have disposed therein a magnetic fluid mixture of oil and metal powder intermixed with abrasive particles 6. Container 5 which may be cylindrical in shape may be attached by suitable means as by welding (not numbered) to a flat disk member 7 on an upper face 8 thereof. Between the upper face 8 and the lower face 9 on the outer circumferential portion of disk 7 may be disposed as by machining, for example, a continuous series of teeth or serrations 10 adapted to be releasably engaged with a pawl member 11. Teeth 10 may be of a shape generally known to the art in conventional pawl and ratchet mechanisms. Disk or turntable 7 may be suitably secured to a shaft member 38 disposed in a central aperture through disk 7 by conventional means as by splines or by key retaining means (not numbered). The lower end of shaft 38 may be suitably attached to a support member 12 which may in turn be fixedly attached as by screws 13 or other conventional means to a rigid support plate member 14.

Pawl member 11 may have a forward surface 15 adapted to engage the teeth or serrations 10 of disk 7 when in disk engaging position of the pawl member and may be slidably disposed to be reciprocated within a pawl bearing support 16. Pawl member 11 may be in the general shape of an elongated bar having a heel portion 17. In bearing relationship with the heel 17 of pawl 11 may be one or a plurality of cams 18 which may be eccentrically or otherwise mounted on a shaft 19 and held in place by suitable means such as abutment means 20 disposed on shaft 19. Abutment means 20 may be retaining keys as shown or may comprise collars with a setscrew arrangement and the shaft 19 may have appropriate flats to receive the setscrew if desired. Shaft 19 may be the output shaft of a speed reducing apparatus 21 which in turn may be driven by a continuously rotating or in the alternative by a variable speed motor 22. Appropriate pawl bias tension means 23 may be provided to constantly urge the heel 17 of pawl 11 against the cam member 18 such that the forward portion or toe 15 of the pawl 11 may selectively engage and be disengaged from teeth 10 or disk 7 in accordance with the cam surfaces of the motor driven cam 18. Bias means 23 may be rigidly attached at one end to bearing support member 16 and at the other end may be attached adjacent the front end 15 of pawl 11 by means such as hook and eye means 24. A second set of cams 25 may be mounted on shaft 19 and spaced from cams 18 for a purpose to be described. Cams 25 may also be secured in predetermined longitudinal relationship along shaft 19 by key means 26, which means may be identical to abutment means 20. Detent means could alternatively be used for this purpose if desired.

Driven by cam member 25 may be a pin member 27 which is slidably disposed in an aperture (not numbered) in a suitable rigid support 28. Pin 27 may function as a switch activating and deactivating means to render switch 34 in selectively and rapidly open and closed position.

Disposed around the inner surface of container 5 as in grooves or helical threads, especially cut therein, for example, are magnetic coils or conductors 29 to create a changing magnetic field therein upon introducing of current in the coils and upon stoppage of the current introduced into the coils to change current carrying conditions within the coil thereby causing a magnetic flux in a manner well-known in the art. Collector rings 30 and 31 attached to terminals 32 and 33, respectively, may serve to carry current to and from the coils as is conventional. One end of switch 34 may be directly electrically connected to terminal 33, the other end of switch 34

being connected in series with a suitable D. C. source 35, the D. C. source having its other end directly connected to terminal 32. Closing and opening of switch 34 by action of pin 27 in response to cam action of cam 25 will thereby cause electromagnetic fields to be set up within the vessel or container 5 thereby causing magnetic energization of the magnetic fluid 6 to cause the particles therein to orient themselves in relation to the magnetic field set up in the container 5. It should be realized of course that the inventive device is by no means to be restricted to a D. C. source, for example, an A. C. output may be directly connected to terminals 32 and 33 in place of the selectively opening and closing switch 34 and the D. C. source to thereby set up a varying magnetic field within the magnetic fluid. A workpiece such as plug gage workpiece 48 requiring surface 39 to be polished may be suspended in alignment with the open end 43 of container 5 by means of a chuck or other work holding device such as eye bolt means 44 shown. Attached to the work holding means may be a bias spring 40 designed to obey Hooke's law which in turn at the end opposite the work holding end may be secured by suitable means to a rigid support member 41. If the work is metallic in nature or capable of magnetization, the work itself being disposed within the coils 29 will behave in solenoid action therewith and cause a vibratory longitudinally vertically upwards and downwards reciprocating motion by means of bias spring 40, the work thereby being alternatively dipped and removed from the magnetic fluid 6 or immersed deeper and shallower in the fluid.

It should be understood, of course, that should the work be non-magnetic in nature or incapable of solenoid action within the coils or conductors 29 in container 5 that suitable other means to provide appropriate vibratory motion of workpiece 48 within the fluid may be provided such as, for example, by gear racks associated with the work holding means or by means disassociated from the means to hold the work so that the work may be moved in and out of or from one position to another within the fluid 6. As illustrated the work should be vibrated within the fluid in accordance with the laws of simple harmonic motion, subject, of course, to friction.

In operation the illustrative embodiment of the inventive apparatus performs as follows: rotation of the motor 22 imparted to the speed reducer 21 causes its output shaft 19 to rotate cams 18 and 25. Rotation of cam 18 forces pawl 11 against bias spring 23 to bear against teeth 10 of turntable of disk 7 causing the disk to rotate in the direction of the arrow. This rotation as shown is interrupted rather than continuous, although if desired mechanism for continuous rotation may be introduced. Container 5 being rigidly secured to disc 7 which disk is rotatably mounted upon shaft 8, also rotates causing some swirl and rotation of the magnetic fluid 6. Simultaneously with rotation of the fluid rotation of cam 25 causes pin 27 to alternately close and open switch 34 to close the circuit at intervals at which time there occurs energization of coils or conductors 29 which may be embedded in or otherwise suitably attached to container 5. If desired coils 29 may be spaced from or insulated from container 5. The forming and collapsing of current through the coils 29 thereby sets up magnetic fields which tend to align the magnetic particles contained in the magnetic fluid. The workpiece 38, if metallic, will be acted upon by solenoid action thereby dipping into and out of or dipping deeper and more shallower in the magnetic fluid 6.

The energization of magnetic particles in magnetic fluid 6 causes the abrasive particles therein to orient themselves to the surface of the article to be polished in such manner as to present abrasive edges in contact with the article. The fluid reservoir or container 5 is mounted for rotation on the rotatable wheel 7 which is turned by the suitable pawl and ratchet means shown and operated by the motor 22. Motor 22, as shown, is

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also connected to a circuit breaker for a direct current source, which circuit breaker allows the magnetic fluid to be alternately activated and deactivated through slip ring connections 30 and 31 to coil 29 in the reservoir housing 5, the article to be polished 48, if metal, being suspended in the magnetic fluid is thereby caused to reciprocate by the energization of the coil 29 and by the resilient suspension means 40 in such manner that finer polishing is achieved and the abrasive particles continually present new abrasive edges in contact with the article. This preserves the life of the abrasive particles and thereby insures optimum automatic operation to effect polishing by the magnetic fluid apparatus and method. Hence, the apparatus achieves automatic reciprocation of the articles to be polished in combination with rotation of the container and contained magnetic fluid while alternately energizing and de-energizing the fluid thereby effectively polishing the article which is held in reciprocative positions within the fluid.

Thus is provided an abrasive-type polisher which is automatic in operation and which utilizes a rotating magnetic fluid which alternately frictionally engages and releases the article to be polished as the article is reciprocated in the magnetic fluid thereby permitting extended duration of effectiveness of the polishing fluid and preventing the abrasive particles therein from becoming clogged or smooth with use and wherein close attention of an operator is dispensed with and a fine finished polish within close tolerances is achieved without marring the surface to be polished.

As heretofore stated obviously many modifications and variations of the present invention are possible in the light of the above teachings. For example an A. C. supply hooked into terminals 32 and 33 can be used instead of the D. C. supply shown, in the case of polishing non-magnetic articles additional motion may be imparted directly or indirectly to the article to cause reciprocating motion of the article deeply and shallowly or within and without the fluid particle mixture, other continuous or discontinuous means for imparting motion to the turntable might be introduced, other switching means such as electronic switching means may be utilized, and other means to activate and deactivate the magnetic field may be instituted to impart the compound motion accomplished by the inventive method and apparatus to effect smooth polishing within close tolerances at a rapid rate which will be both effective and economical in use. In view of the many modifications and variations possible in the light of the above teachings it is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a magnetic fluid abrasive polisher for materials comprising a rotatable member, intermittent drive means including a spring biased pawl in constant engagement with said rotatable member for rotating the rotatable member, a magnetic fluid reservoir fixedly mounted on said rotatable member, means overlying said rotatable member and aligned with said reservoir to reciprocate the material to be polished within the reservoir, and energizing means to alternately activate and deactivate the magnetic field in said fluid whereby the magnetic particles in said fluid present in each energization a different contact surface to abrade the article.

2. In an apparatus to polish materials comprising a rotatable member, a support member to support said rotatable member, an open ended container for magnetic fluid rigidly attached to said rotatable member, means to reciprocatingly support a workpiece of the material disposed in vertical alignment with the opening to said container member, drive means including a spring biased pawl in constant engagement with said rotatable member for rotating said rotatable member intermittently, means disposed on said container to alternately activate and de-

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activate the magnetic fluid contained therein, means to selectively energize and deenergize said activating means, thereby permitting abrasive particles in said fluid to become continually oriented in response to the magnetic field selectively set up at intervals therein to present a different abrasive contact surface to the workpiece at each energization.

3. Polishing apparatus for polishing workpieces comprising a support plate, means fixedly attached to said support plate to support a rotatable shaft, a disk member having an upper face, a lower face and a circumferential edge portion, the disk member being fixedly secured to said shaft to rotate therewith, teeth members disposed on the circumferential edge portion of said disk member, a container for magnetic fluid rigidly attached to and concentric with said disk member, said container having an upper open end, a lower closed end and a cylindrically shaped wall, work suspension means disposed in alignment and concentric with the open end of said container to reciprocatingly support a workpiece for longitudinal motion in a vertical direction upwards and downwards relative to and inside the container, a magnetic fluid comprising oil, metal powder and abrasive particles retained within said container, pawl means adapted to engage the teeth of the disk member to impart thrust for rotation of the disk member and shaft, cam means to drive said pawl means into and out of engagement with said disk teeth, means to rotate said cam means, means to interruptedly establish a magnetic field within said container to orient the abrasive particles in the fluid contained therein, rotation of the container and its magnetic fluid combined with reciprocating motion of the workpiece and energizing and deenergizing of the magnetic field to orient the particles in the magnetic fluid thereby permitting polishing of the workpiece within close tolerances, the magnetic particles in said fluid presenting different contacting surfaces to abrade the article at each energization.

4. Apparatus for polishing a workpiece, said workpiece being supported to reciprocatingly move upwards and downwards in a vertical direction, said apparatus comprising a container having a cylindrical wall closed at one end and an upper opening at the other end thereof aligned with and of size to receive the workpiece, a substantially disk shaped rotatable member rigidly secured to the closed end of said cylindrical wall for supporting said container, a magnetic fluid comprising a mixture of oil, metal powder and abrasive particles retained within said container, means to rotatably support said disk member, interruptedly applied means including a spring biased pawl in constant engagement with said disk shaped member for rotating said disk member gradually, means including a coiled electrical conductor disposed within and forming a part of said cylindrical wall and extending substantially the full length thereof for selectively establishing and disestablishing a magnetic field within the magnetic fluid to cause the particles therein to align themselves in relation to said workpiece, motion of said workpiece in an up and down vertical direction combined with energization and deenergization of the magnetic fluid, accompanied with rotation of the container thereby causing the particles in said fluid to present a different contact surface to abrade the workpiece at each energization thereby causing rapid energization without damage to the magnetic fluid.

5. A magnetic fluid abrasive polisher for materials comprising a first rigid support member, a second support member mounted on said first rigid support member, a shaft member mounted in said second support member, a turntable member rotatably mounted on said shaft, a container member having a lower closed end, a cylindrically shaped sidewall and an open end rigidly attached to and concentric with said turntable member, electrical conductor means wound in said container, a magnetic fluid of oil, metal and abrasive particles retained within said container, energization of said coil causing

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orientation of the magnetic particles contained therein, reciprocating means to support a workpiece of the materials in alignment with the open end of said container, to thereby cause the workpiece to move into and out of the container in response to mechanical actuation of the reciprocating support means by the workpiece, a first collector ring and a second collector ring disposed concentric with the periphery of cylindrical portions of the container, a contact means bearingly supported against each of said collector rings, means to actuate said conductor means through said collector rings comprising a D. C. source connected in series with the first of said contact means, a switch member connected in series with said D. C. source at one end and having its other end connected to the other contact means, means to actuate said switch member to selectively open and closed position, said switch actuating means comprising a pin member and a first cam member to drive the pin member against the switch to cause it to selectively open and close, a shaft supporting said first cam member, a second cam member mounted on said shaft, a motor to impart rotational movement for driving said shaft, a pawl member, a bearing support to slidably receive said pawl member for lateral motion therein, said pawl member having a heel portion and a toe portion, the heel portion being

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in abutting relationship with said second cam to be driven thereby in response to rotation of said cam supporting shaft, means disposed on the circumference of said turntable member adapted to be driven by the toe of said pawl member, said pawl member coming into engagement and disengagement selectively with the means disposed on said turntable member to cause turntable rotation in response to actuation of said second cam, bias means disposed between said bearing support and the toe of said pawl member to constantly urge the pawl against the second cam surface, motion of the work in reciprocating directions into and out of the container accompanied by rotation of the container and selective energization and deenergization of the magnetic fluid contained in the container causing the magnetic articles in said fluid to present a different contact surface to abrade the workpiece at each energization.

References Cited in the file of this patent

UNITED STATES PATENTS

2,480,502	Nieder	Aug. 30, 1949
2,664,676	Cuppers	Jan. 5, 1954
2,735,231	Simjian	Feb. 21, 1956