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Development Report:

Deburring Finishing Using a Magnetic Polishing Machine

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This article describes a magnetic polishing machine. Pritic, which is a deburring finishing machine that uses permanent magnets and magnetic media to remove fine and tiny burrs arising in metalwork and polish workpieces. Being a magnetic Polishing machine, Pritic can finish metal or nonmetal workpieces regardless of whether they are magnetic or not. It can even finish lengthy objects with the correct configuration. Examples of its work show that Pritic is an effective finishing machine.

Keywords: deburring, magnetic polishing machine, permanent magnets, magnetic media

1. Introduction

We would like to present a magnetic polishing machine Pritic, a deburring finishing machine that rotates discs with permanent magnets disposed in such a way that it removes fine and tiny burrs arising in metalwork and polish workpieces through the medium of a magnetic material (sus304).

We started research and development work on the magnetic polishing machine in 1987 and established its processing method in 1990.

A US patent was granted in 1991 [1]. We then started sales to the Japanese jewelry industry. Japanese and European patents were granted in 1994 [2].

Since then, orders have come in from the automotive, medical equipment, and light electrical appliance industries. We have developed nine magnetic polishing machines to which the patent has been applied. A magnetic polishing machine is often called a magnetic barrel.

2. Principle of Magnetic Polishing Machine

The machine has a simple structure with a magnet board under a polishing tank (**Fig. 1**). The magnet board rotates so that media reacts by moving among workpieces at a high rate of speed (**Fig. 2**). As the media, workpieces, and aqueous solution are put into the container and the magnetic polishing machine is actuated (**Fig. 3**), the disc moves so that north and south poles alternate equally at high speed (**Fig. 4**). In such a magnetic field, pin media (**Fig. 5**) are affected by the approaching strong and weak magnetic field lines from the opposite pole that , and, while being pulled together, they alternate coupling in chains and invert with respect to north and south poles instantaneously (**Figs. 6** and **7**). In the container provided in the polishing tank, the high-speed rotation of the pol-

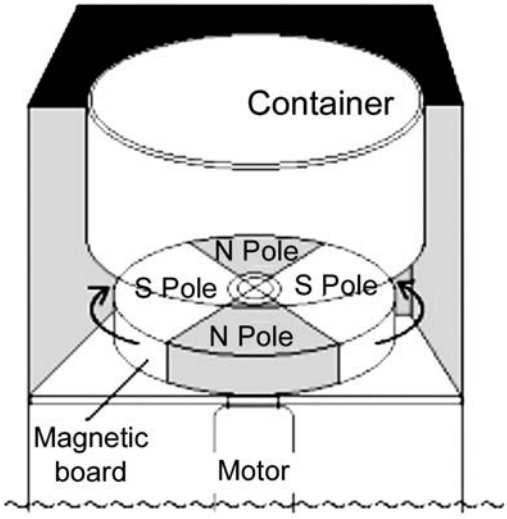


Fig. 1. Structure of machine.

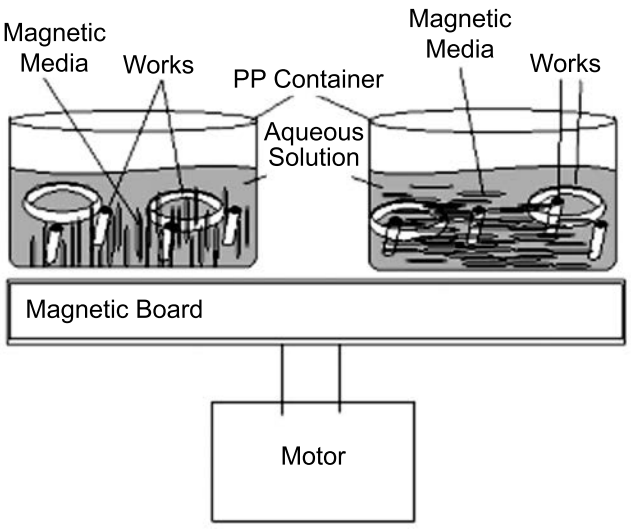


Fig. 2. Movement of media.

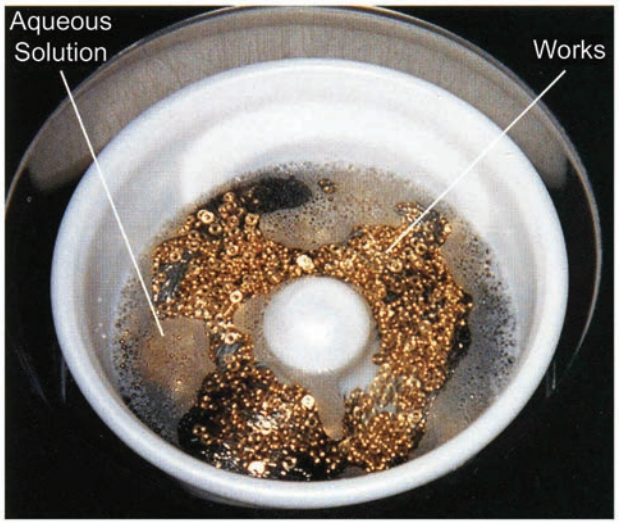


Fig. 3. Works, media, and aqueous solution.

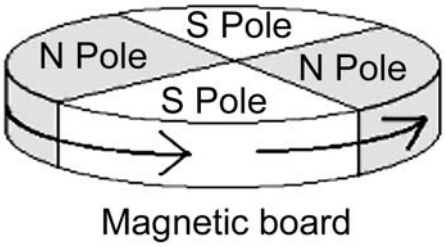


Fig. 4. North and south poles on magnetic board.

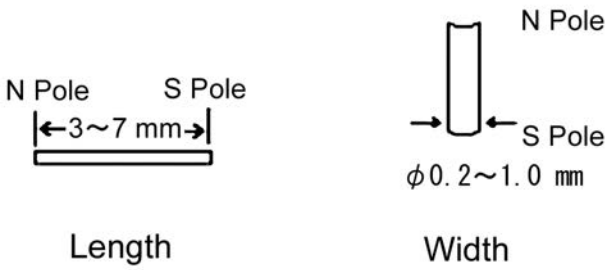


Fig. 5. Shape of pin media.

ishing board causes the media and wash solution to generate complex water flows (**Fig. 8**). The media come in contact with the outer and inner surfaces of the workpieces in the container (**Fig. 9**). This contact removes fine and tiny burrs arising in the inner surfaces of pipes and slotted sections. and it polishes the workpieces.

3. Examples of Works

3.1. General Cutting Workpieces

As cutting work is done on stainless, fine burrs arise on the cut surfaces (**Fig. 10(a)**). On the other hand, burr is completely removed (**Fig. 10(b)**) after 10-minute deburring using the Pritic M [3] (**Fig. 11**) with media of $\phi 0.5 \times 5$mm.

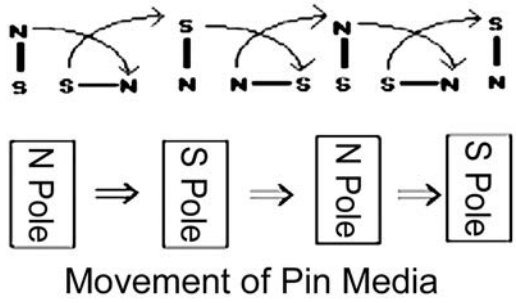


Fig. 6. Movement of pin media.

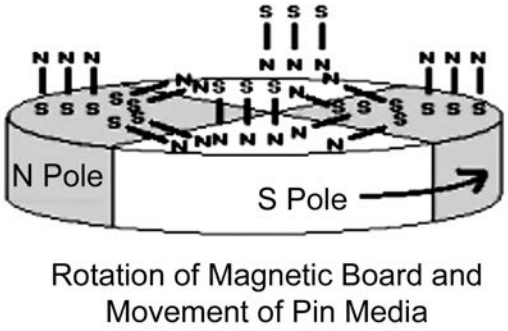


Fig. 7. Rotation of magnetic board and movement of pin media.

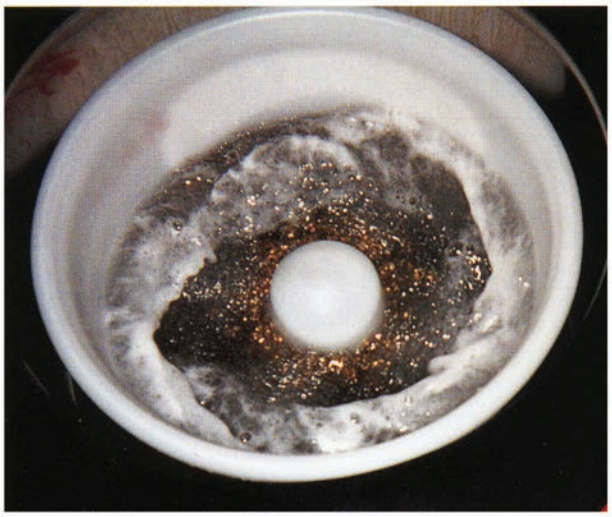


Fig. 8. Water flow during operation of magnetic polishing machine.

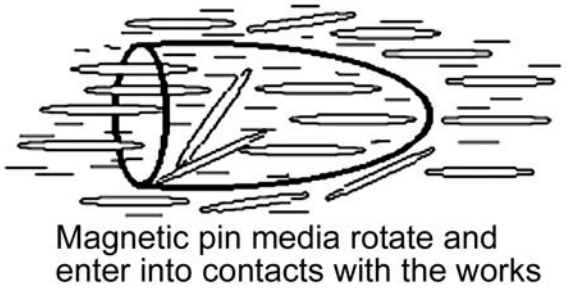
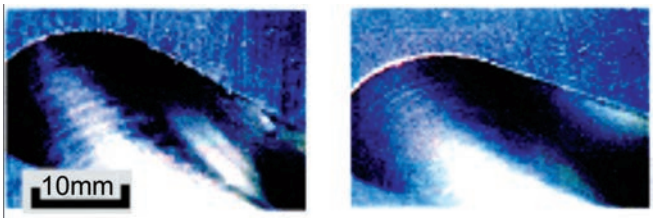


Fig. 9. Contact of pin media and works.



(a) Before the work (b) After the work

Fig. 10. Examples of stainless burr by cutting work.

Size: 780 high × 770 wide × 515 long
Capacity Size: 300 in diameter × 150 high
Number of Rotation: 10 Hz to 60 Hz (controlled by controller)
Power: Single Phase AC100 or Three-phase AC 200 to 230 V
Output: 0.75 KW

Fig. 11. Pritic M.

3.2. Removing Fine Burr

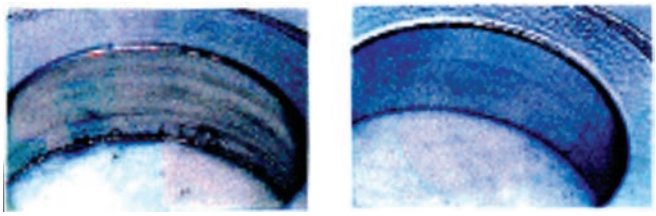
Right after cutting work is provided on stainless, fine burr arises in cutting surfaces (**Fig. 12(a)**). On the other hand, burr is completely removed and moreover the shape of edge is maintained (**Fig. 12(b)**) under the same condition as in **Fig. 10**.

3.3. Spring-Like Workpieces

Tiny burr is removed from a spring of $\phi 0.3$ thick and 10 mm long after 10-minute deburring using the Pritic M with media of $\phi 0.5 \times 3$ mm, having no deformation and no change in the shape (**Fig. 13**).

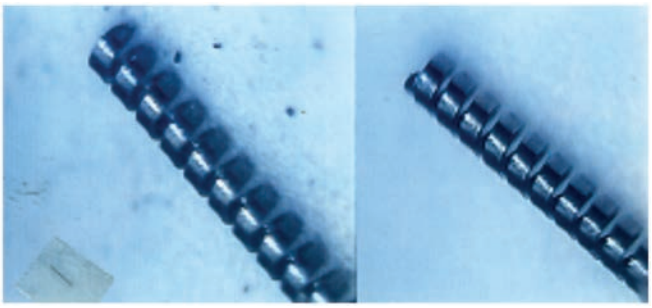
3.4. Removing Bore Burr

During brass cutting work, bore burr is removed after 8-minute deburring using the Pritic M with media of $\phi 0.5 \times 5$ mm (**Fig. 14**). At the same time, slag is removed and inside is washed.



(a) Before the work (b) After the work

Fig. 12. Examples of stainless burr by cutting work (50 mm × 8 mm).



(a) Before the work (b) After the work

Fig. 13. Examples of burr in plastic working ($\phi 0.3 \times 10$ mm).

(a) Before the work (b) After the work

Fig. 14. Examples of inner burr of brass materials ($\phi 6$ in outside diameter, $\phi 5$ in inside diameter, and 26 mm in length).

4. Target Materials to be Processed Using Magnetic Polishing Machine

The machine can work on almost all metallic materials including stainless, aluminium, zinc die-cast, copper, and furthermore, iron, which has not been able to be worked on by magnetic polishing machines.

The magnetic polishing machine uses magnets and magnetic media for deburring finishing. Although the machine originally targeted only non magnetic materials, mechanical displacement of the magnetic field allows magnetic media to have a deburring finishing effect even on iron materials.

Also, the machine is used for long objects thanks to displacement of the magnetic field in a range where magnetic field lines can be effectively used (**Fig. 15**).

Slider III [4], for instance, uses a rectangular container to work on long objects with the range of application of 1000 mm at maximum and uses a round container on the

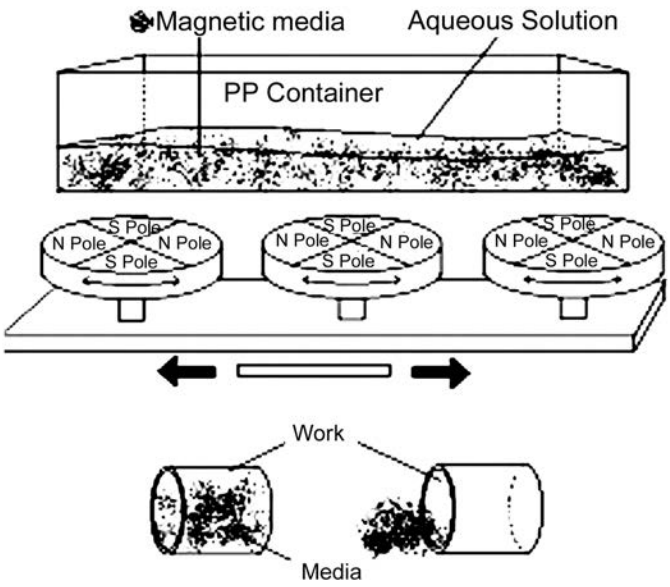


Fig. 15. Application to iron materials and long objects.

magnet board as a production model of Pritec M (**Fig. 12**).

Using two or more containers, the machine can work on metallic materials of 400 mm wide and 1000 mm long or shorter.

5. Notes in Deburring Finishing

The following are notes in deburring using the magnetic polishing machine:

(1) Use a wet polishing tank.

(2) Decide the size of the media according to the size of the material and burr and hole diameter.

(3) Decide the length of machining time and the number of rotations according to the size of the material and burr.

(4) Decide the media, wash solution, the length of machining time, etc. according to the purpose of use.

(5) Select the model according to the material, shape, and work amount.

When removing burr inside the workpieces or of the slitting sections, each of the media should be shorter than the hole diameter of the workpieces so as to allow the media to pass naturally through them and prevent the media from being stuck. Thus, selection of media is important for deburring finishing using the magnetic polishing machine.

The difference in the magnetic polishing machines Pritic lies in the difference in magnetic force of the magnetic board under the polishing tank and the range of effect.

The tabletop Pritic SP is used for deburring small normal aluminium or brass workpieces, where the number of rotation of 900 rpm to 1200 rpm is sufficient.

Fig. 16. Use of jigs.

Size: 730 high × 1400 wide × 555 long
Container size: 150 to 250 high × 100 to 450 wide × 1200 long
Number of Rotation: 10 Hz to 60 Hz (controlled by controller)
Power: Three-phase AC 200 to 230 V
Output: 2.5 KW

Fig. 17. Pritic and Slider III.

The Pritic M (**Fig. 11**) is used for deburring workpieces over 800 g in total weight, for a higher rotation speed, for finishing materials such as stainless or titanium. Even if the amount of the workpieces is small, the Pritic M is also used for a higher rotation speed of the media or for the media of $\phi 0.8$ or greater.

During deburring finishing, the media and the workpieces float intricately (**Fig. 8**). However, it is possible to fix the workpieces and to float only the media by attaching jigs to the container (**Fig. 16**).

Only Pritic and Slider can work on iron materials regardless of the size and the amount of workpieces (**Fig. 17**).

6. Examples of Use of Magnetic Polishing

Although fine and tiny deburring finishing by magnetic polishing is worked mostly on workpieces of metallic materials, so is on those of hard plastic. Although the purpose of use of the magnetic polishing machine varies, the following effects are required in most cases.

(1) Equal polishing of workpieces to improve surface finishing even if they have complicated shapes

(2) Removal of fine and tiny burr that arises during work on the insides of pipes, slits, and slots

(3) Removal of dross and tiny burrs that arise in laser processing

(4) Removal of burrs and exfoliation in screws and polishing

(5) Fine deburring of magnetic materials

(6) Finishing washing

Meticulous process control improves the machine in these effects, i.e., reduction of deburring time and achievement of high-quality products. That is, to know well burr state is an important key of deburring finishing.

7. Conclusions

We have developed the magnetic polishing machine Pritic, a deburring finishing machine that uses permanent magnets and magnetic media so as to remove fine and tiny burr and polish workpieces, and demonstrated its effectiveness.

The way to high-quality products lies not in 'nonexistence of burr' but in constant understanding of the state of burr, and selection of media and decision of work time and input amount based on the understanding.

It is significant to recognize that deburring finishing is a very delicate process for achievement of high-quality products.

References:
[1] US Patent No.5044128
[2] JP Patent No.1849626, EU Patent No.0478805
[3] PRITIC M, http://www.priority.co.jp/Product_Info/pro_LINEUP.html#PM
[4] PRITICSLIDER, http://www.priority.co.jp/Product_Info/pro_LINEUP.html#SL

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Brief Biographical History:
1998 Development of the type of magnetic polishing machine which can finish lengthy objects
1999 Development of the processing method to remove burrs from magnetic materials using magnetic polishing machine
2000 Completion of magnetic polishing machine for lengthy object and magnetic materials
2007 Development of the combined type machine of rotation barrel with magnetic polishing machine
2008 Presentation of trial magnetic polishing machine dram (awarded the prize of the New Technology Competition of New Products by Small Companies in Ota-Ku)

Main Works:
• The research and development of Magnetic Polishing Machine