# United States Patent [19]

**Nielsen**

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[54] **MACHINE FOR GRINDING AND POLISHING METALLOGRAPHIC AND MINERALOGIC SAMPLES**


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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **51/110,** 51/123 R

[51] **Int. Cl.** ..... **B24b 7/02**

[58] **Field of Search** ..... 51/110, 122, 123



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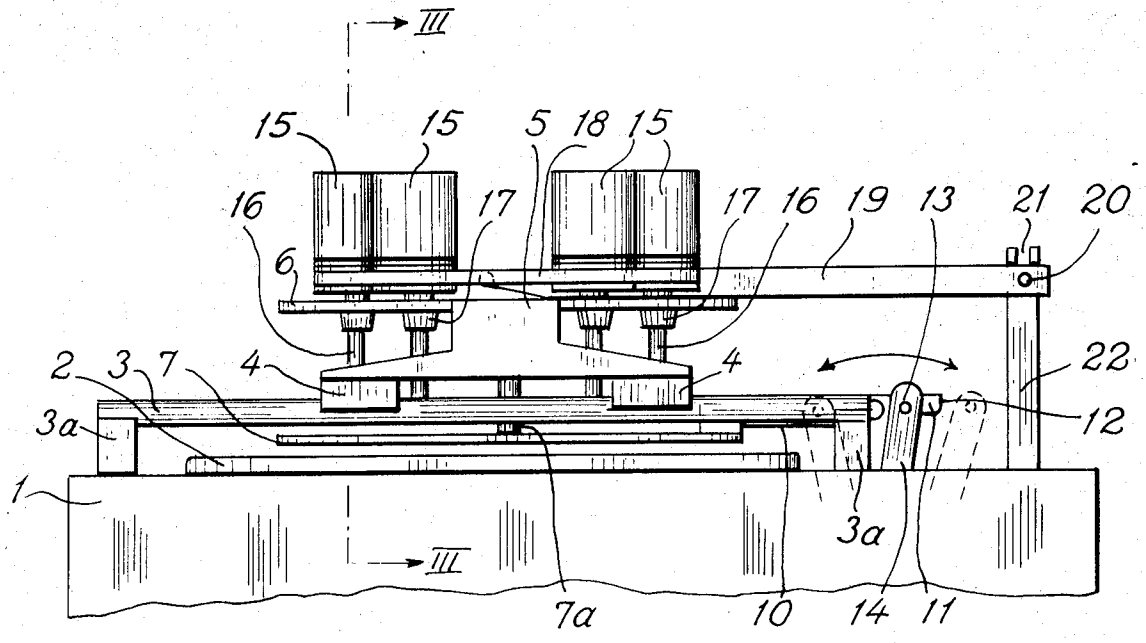
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[57] **ABSTRACT**

A machine for grinding and polishing metallographic and mineralogic samples, in which a sample holder having a plurality of apertures for rotatably receiving samples embedded in a cylindrical body of synthetic resin, or the like, is subjected to rectilinear reciprocatory movement along the face of a rotating abrasive disc, one end of the sample bodies engaging the abrasive face thereof. The apertures of the sample holder are distributed over an area corresponding to a relatively large portion of the abrasive face of the abrasive disc, so as to result in a large capacity of the machine and, hence, a great output thereof, while still insuring a substantially uniform rate of abrasion and a plane polished face of each sample in the sample holder. Means may be provided for imposing a reciprocatory rotary movement on the samples about their axes during grinding and polishing. The rectilinear guide means required for the rectilinear reciprocatory movement of the sample holder may, in a further development of the basic idea of the invention, be extended over a plurality of aligned abrasive discs, so that a multi-stage grinding and polishing machine is provided in which the sample holder with the samples accommodated therein may after each stage of grinding or polishing, be conveyed along the guide means to the next stage, thus avoiding the necessity of removing the samples from the sample holder between consecutive stages of grinding and polishing. In this form, a plurality of sample holders may be used, simultaneously at the various abrasive discs and be passed on to the next disc after each other between consecutive stages of grinding and polishing. If desired, rinsing baths may be provided between the abrasive discs.


**11 Claims, 7 Drawing Figures**



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4 Sheets-Sheet 1

Fig. 1

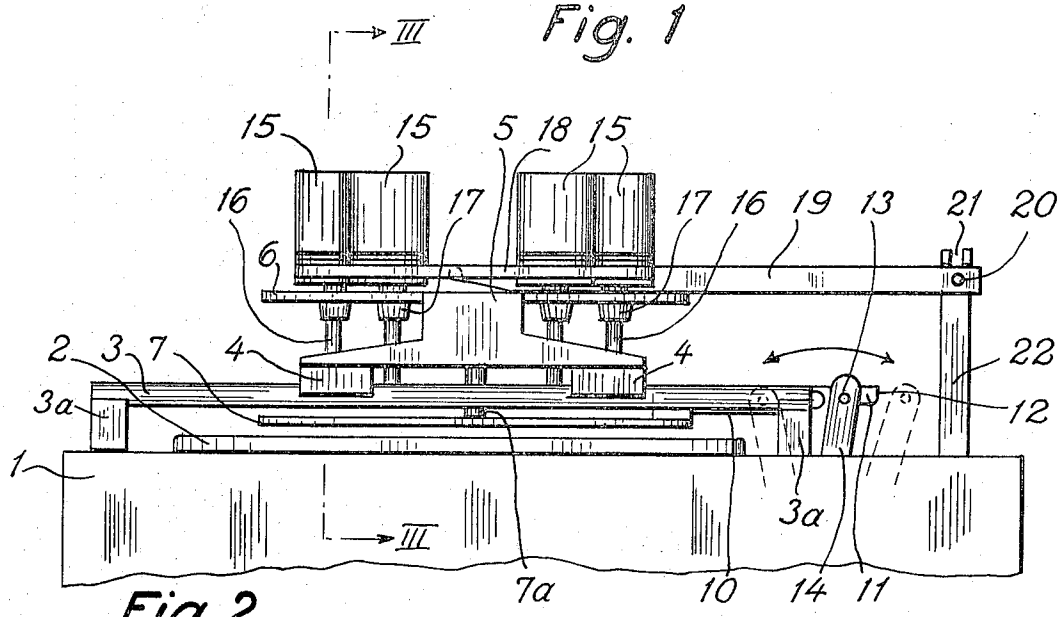
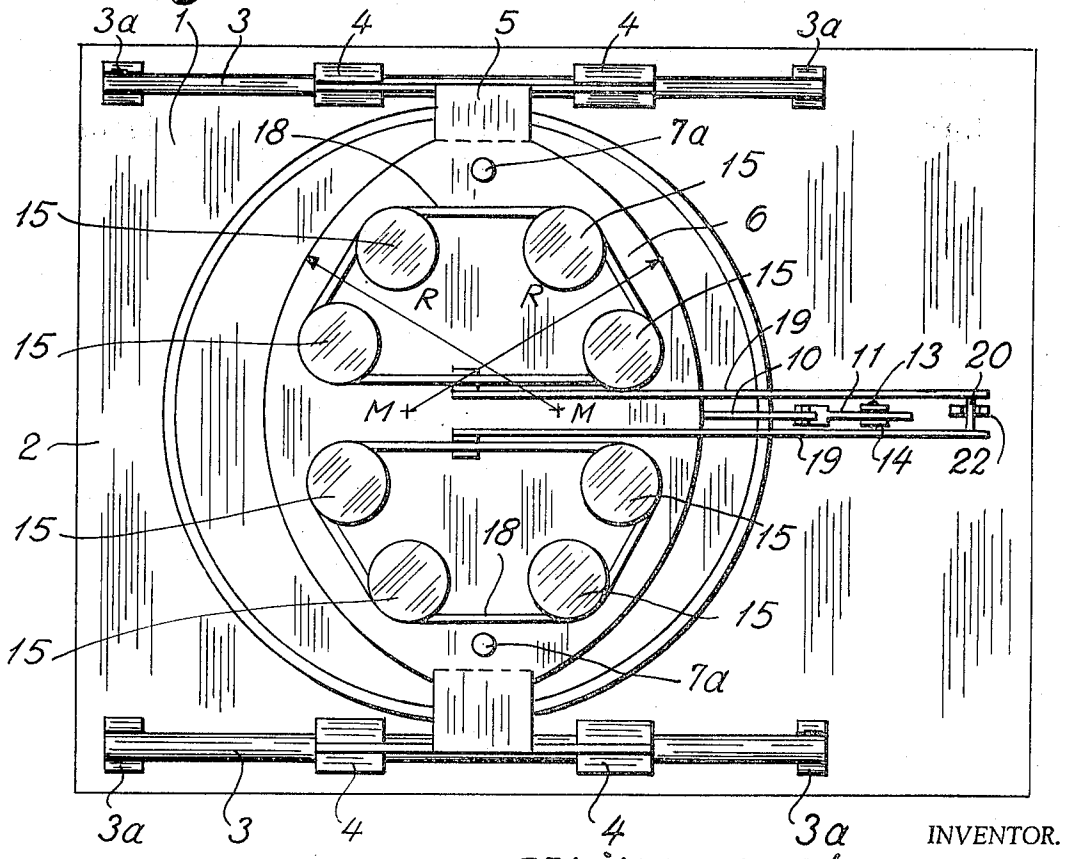



Fig. 2




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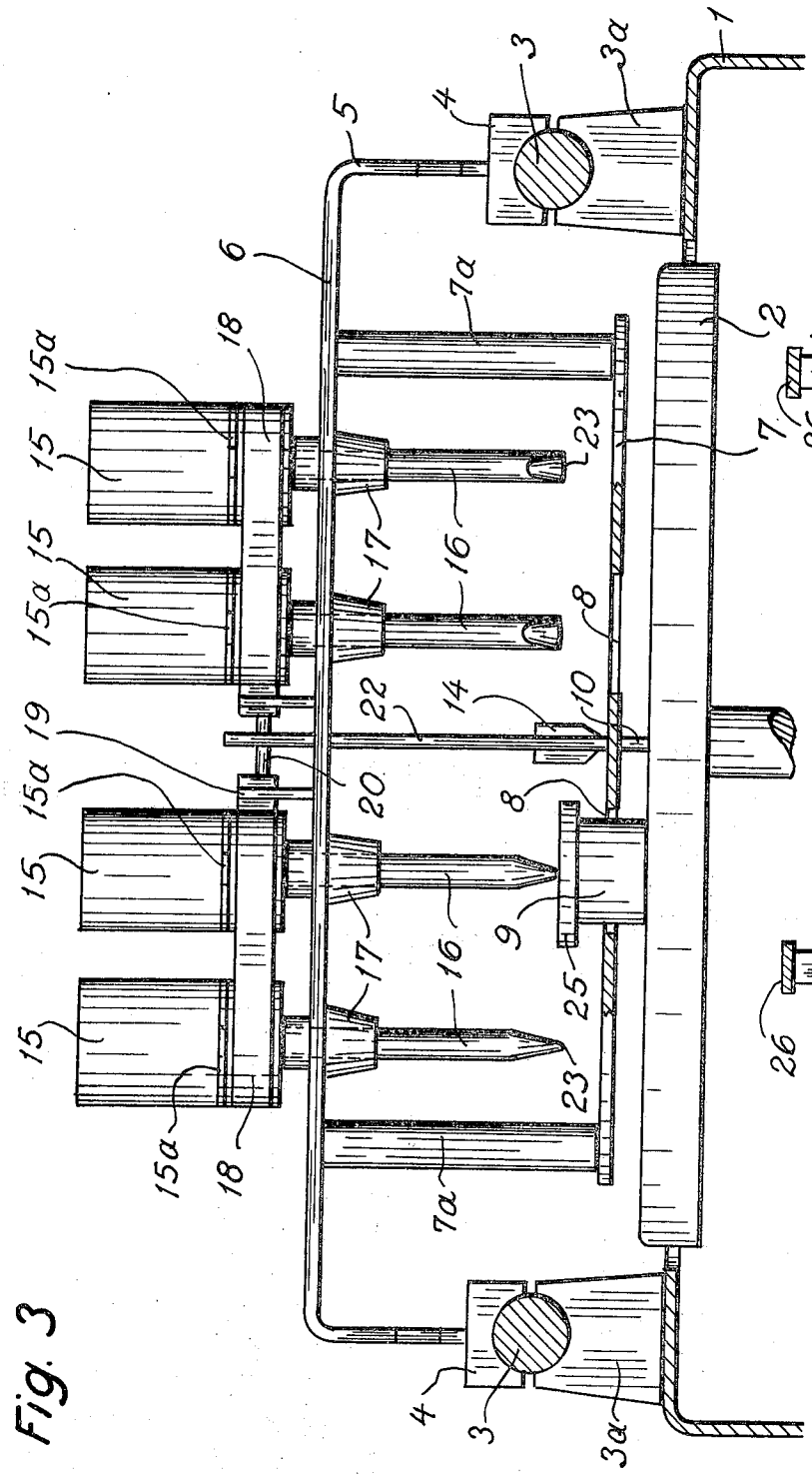



Fig. 3

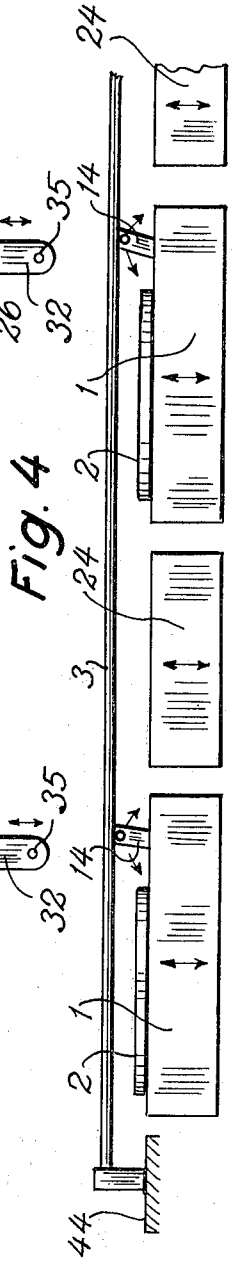



Fig. 4

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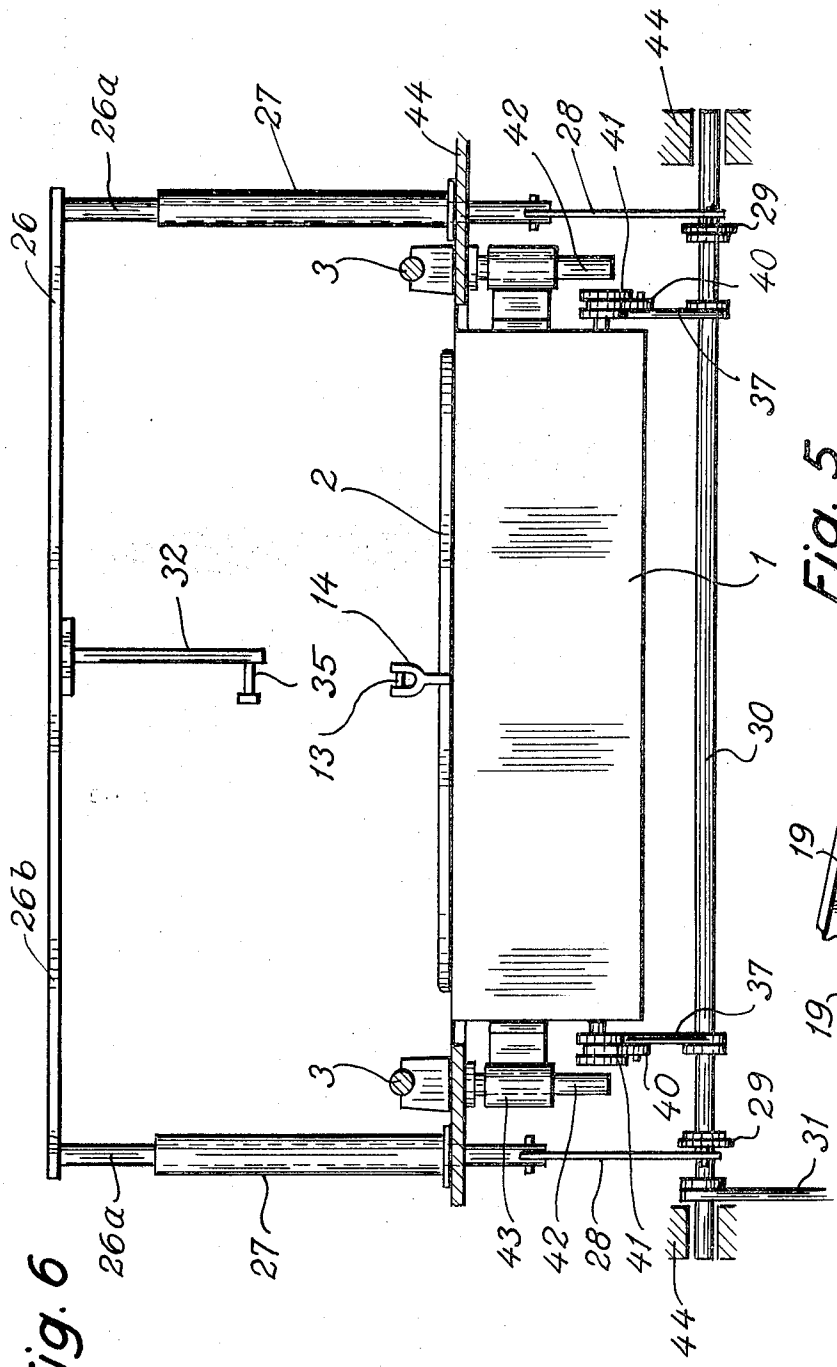



Fig. 6

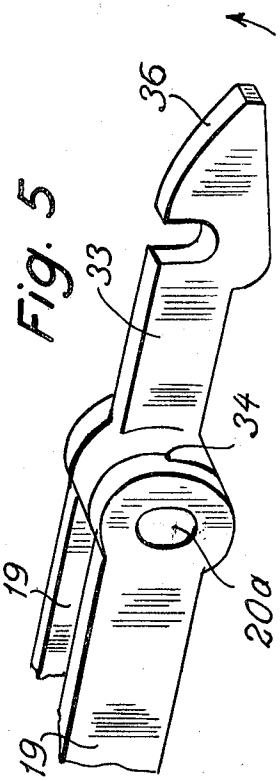



Fig. 5

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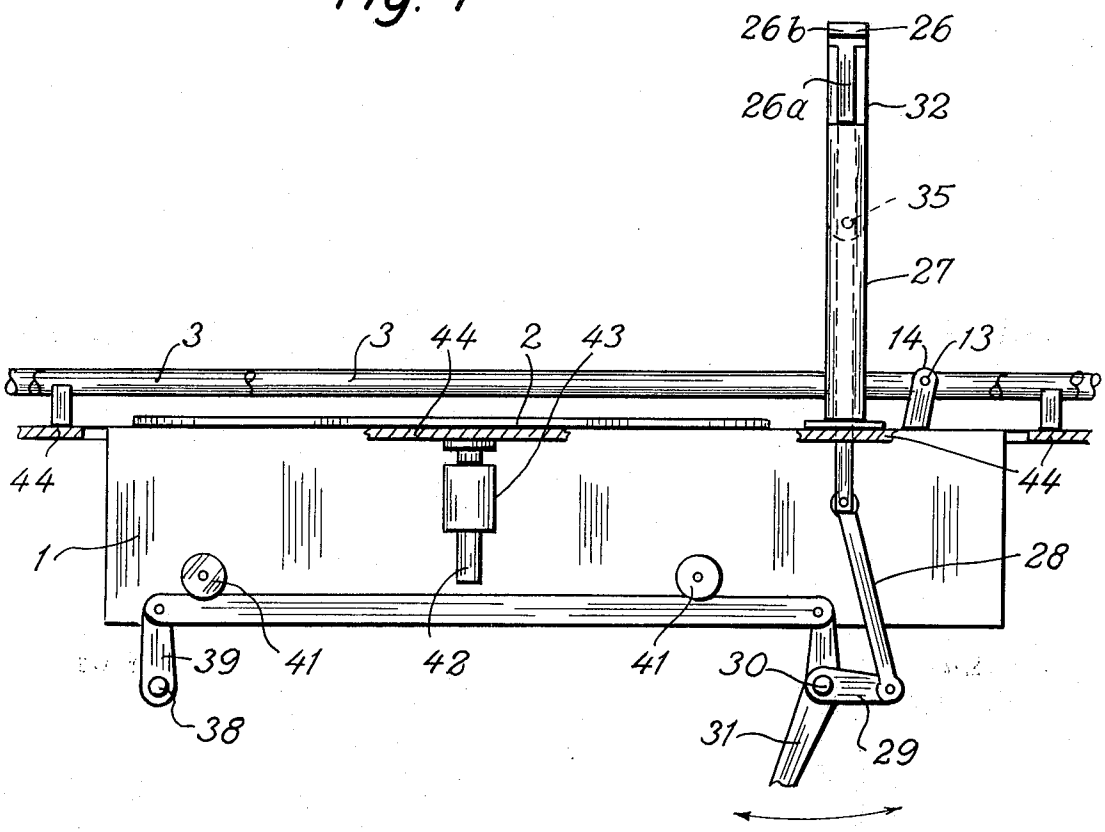
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Fig. 7




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# MACHINE FOR GRINDING AND POLISHING METALLOGRAPHIC AND MINERALOGIC SAMPLES

This invention relates to machines for grinding and polishing metallographic and mineralogic samples or the like. More specifically, the invention is concerned with machines of the type having a powerdriven rotary abrasive disc and a sample holder mounted for movement relative to the abrasive disc in a plane parallel thereto and provided with a plurality of apertures, each for receiving a sample embedded in a cylindrical body of synthetic resin, means being provided for moving the sample holder relative to the abrasive disc.

When grinding and polishing metallographic and mineralogic samples, it is important that the polished faces produces should be as plane and even as possible. Furthermore, the abrasion traces should not extend in one and the same direction across such faces, but in constantly changing directions. To this effect, various forms and movement patterns of the sample holder have been suggested.

So far, one of the best forms of the machine in question is one in which the sample holder is pivoting back and forth about an axis which is parallel to that of the abrasive disc and situated outside the circumference of the latter, the sample holder receiving the samples for free rotary movement in its apertures. If provisions are made to insure that the samples pass as closely as possible to the centre of the abrasive disc during the pivoting movement of the sample holder, the friction of the abrasive disc will impart an alternating rotary movement to the samples about the axes thereof, whereby a very even and plane polishing may be obtained.

However, the condition that all samples should pass as closely as possible to the centre of the abrasive disc requires the samples to be clustered rather narrowly around the centre of the sample holder, so that as a rule the capacity of the sample holder will be limited to three or four samples only. This puts a very narrow limit to the output of the polishing device, which is the more inconvenient as the grinding and polishing of samples constitute a bottle-neck in metallographic laboratories.

It is an object of my invention to provide a grinding and polishing machine having an increased output as compared with that of the known devices discussed hereinbefore.

To this effect, another object is to provide a grinding an polishing machine, the sample holder of which is adapted to receive a considerable number of samples, while at the same time insuring an even rate of plane polishing to each sample.

Another object is to provide a grinding and polishing machine, the sample holder of which is adapted to effect reciprocatory movement along rectilinear guide means parallel to the face of the abrasive disc, and has its apertures for receiving the samples distributed over an area which, in a direction at right angles to said guide means, extends over the greater part of the diameter of the abrasive disc, so as to insure a maximum capacity of the sample holder.

A further objects is to provide a grinding and polishing machine having rectilinear guide means for the sample holder extending over a series of aligned abrasive disc so as to permit the sample holder with the samples accommodated therein to pass from one abrasive disc to the next for effecting consecutive stages of grinding and polishing of the samples without the necessity of removing the same from the sample holder, or removing the latter from the machine.



Other objects and advantages will appear as this specification proceeds, reference being now had to the accompanying drawings, in which:

FIG.1 is a side view of one form of the machine in accordance with my invention,

FIG.2 is a plan view of the same,

FIG.3 is an enlarged end view, part thereof being a sectional view along the line III—III in FIG.1,

FIG.4 is a diagrammatic side view of another form of the machine in accordance with my invention comprising a series of aligned abrasive disc with interposed rinsing baths,

FIG.5 is an enlarged perspective view of a detail of a sample holder for use with the machine of FIG.4, and

FIG.6 and 7 are a cross sectional view and a side view, respectively, of a grinding and polishing unit of the device of FIG.4.

Briefly outlined, the basic principle of my invention is that a sample holder rotatably receiving a plurality of samples embedded in cylindrical bodies is adapted to reciprocate, without pivoting or rotary movement, along rectilinear guide means parallel to the face of the abrasive disc. In this manner it becomes possible to distribute the samples over a large area which is only limited by the requirement that, during the reciprocatory movement of the sample holder, all samples should remain within the circumference of the abrasive disc. It has been found that, subject to this condition, all samples will be subjected to practically the same degree of abrasive action, while alternatingly passing faster and slower running portions of the abrasive face.

Referring now to FIGS. 1 – 3, 1 is a housing including a prime mover (not shown) for an abrasive disc 2 adapted to rotate about a vertical axis and having its active surface projecting from the top of the housing 1. A pair of parallel guide bars 3 are mounted on brackets 3*a* on the top of the housing 1, so as to be spaced from the latter and to extend on opposite sides of the abrasive disc 2 in a plane parallel with the face of the latter.

The guide bars slidably receive a sample holder 5 provided with slide shoes 4 which engage the guide bars on part of the circumference thereof only, so as to permit the sample holder to be easily lifted off from the guide bars. The sample holder comprises an upper plate 6 connected with the slide shoes 4, and a lower plate 7 spaced a small distance above the face of the abrasive disc 2 and connected with the upper plate 6 by means of vertical rods 7a. The lower plate 7 is provided with a plurality of circular apertures 8 for receiving cylindrical samples. Two such apertures 8 are shown in section in FIG.3, a sample 9 being shown in one aperture.

It is common practice to place metallic samples in a cylindrical mold which is then filled with synthetic resin. The resulting cylindrical body with the metal piece embedded therein is then ground at one end face, until the desired cross section of the metal piece is laid bare and polished.

For the purpose of imparting reciprocatory movement to the sample holder 5 along the guide bars 3 relative to the abrasive disc 2, the lower plate 7 is provided with a rigid arm 10 which is parallel to the guide bars 3 and which at its free end is provided with a spring-

loaded hook or latch 11 having an inclined cam face 12. When the sample holder 5 is placed on the guide bars 3, the latch 11 will become engaged with a cross pin 13 at the upper end of a pivotable lever 14 projecting through the top of the housing 1, the lever 14 being adapted to the pivoted back and forth in the directions of the arrows (FIG.1) by means of some suitable driving means (not shown), so as to cause the sample holder 5 to reciprocate along the guide bars 3 relative to the abrasive disc 2. This reciprocatory pivoting movement of the lever 14 is effected at a relatively slow rate, in order to substantially reduce the inertia forces exerted on the samples 9 accomodated freely rotatably in the apertures 8, such forces having a tendency to tilt the samples and thereby to jeopardize the production of a plane polished face.

The samples 9 are urged against the disc 2 not only through their own weight, but in addition through a load 15 placed on each sample. These loads 15 are provided with shafts 16 which, in a manner to be described in greater detail hereinafter, are rotatably mounted in the upper plate 6, concentrically to the apertures 8 of the lower plate 7, while at the same time being axially displaceable. placeable. The spatial distribution of the loads 15 shown in FIG.2, therefore, also applies to the apertures 8.

In the example shown, the sample holder 5 is provided with eight apertures for receiving samples, these apertures being distributed within a configuration of the plate 7 which is composed substantially of two arcs of a circle having radii R substantially equal to that of the disc 2, and having their centres M placed on a line parallel to the guide bars 3 and intersecting the axis of the disc 2, the centres M being spaced a distance apart which is substantially equal to the stroke of the reciprocatory movement imparted to the sample holder 5 by means of the pivoting lever 14. The plate 7 itself may, of course, extend beyond the configuration thus defined, provided that the apartures 8 for receiving the samples remain within this circumference in order to insure that the samples are not pushed beyond the circumference of the disc 2.

As will be noted, the configuration defining the distribution of the apertures 8 has its greater dimension in the direction at right angles to the guide bars 3, this dimension being substantially more than half the diameter of the disc 2.

The rotary mounting of the loads 15 in the upper plate 6, briefly referred to hereinbefore, will now be described in greater detail.

The upper plate 6 is provided with bearings 17 which are co-axial with the apertures8 of the lower plate 7 and which each rotatably mount a belt pulley 15*a* so as to hold the same against axial displacement. The shafts 16 of the loads have a non-circular, e.g., square, section and the belt pulleys are formed with corresponding central openings for receiving the shafts, so that the loads and their shatfs are coupled with the belt pulleys for rotation therewith, but are axially displaceable relative thereto.

As will be apparent from FIG.2, the loads 15 and their belt pulleys 15a (and consequently the aperture 8, too) are arranged in two groups of four each, placed symmetrically on either side of the centre line M—M. A driving belt, preferably a toothed belt 18, is placed around each group of belt pulleys so a to engage the circumferential grooves thereof. The portions of the driving belts 18 extending between the pairs of belt pulleys adjacent the centre line M—M are each connected with a pivotable rod 19 extending beyond the configuration of the plates 6 and 7. Both rods 19 are, at their free ends, connected with each other by means of a pin 20 which can be caused to engage a vertical slot 21 formed at the upper end of a bracket 22 secured to the housing 1. Thus, when the sample holder 5 reciprocates along the guide bars 3 under the action of the pivotable lever 14, the points of connection between the rods 19 and the driving belts remain stationary in space, whereby an alternating rotary movement is imparted to the belt pulleys and, consequently, to the loads 15. This alternating rotary movement is transmitted through the shafts 16 to the samples 9, the lower end of each shaft being formed with a screwdriver tip 23 engagin the upper end of the corresponding sample and thereby insuring a sufficiently firm driving connection between the loads and the samples. The relative direction of grinding at the lower faces of the samples thus changes constantly, not only because of the rectilinear displacement of the samples along the face of the abrasive disc 2, but also because of the rotary movement imparted to the samples.

As will be apparent, the rods 19 and the rod 10 of the sample holder are easily releasably connected with the bracket 22 and the pivoting lever 14, respectively, so that the sample holder 5 is easily removable from the guide bars 3, so as to allow changing or cleaning of the grinding cloth of the abrasive disc, for example. The machine further comprises a receptacle (not shown) from which a grit suspension is supplied drop by drop to the abrasive disc. Such receptacles are well-known in the art and need not be described in detail.

FIGS. 4 to 7 illustrate another form of a grinding and polishing machine in accordance with my invention and comprising a plurality of aligned abrasive discs 2 with interposed rinsing baths 24. In this embodiment of my invention, the guide bars 3 are mounted in a machine frame 44, of which only fragments are shown and which may be formed in any convenient manner. The guide bars extend continuously over the entire series of abrasive discs 2 and rinsing baths 24 so as to allow a sample holder to slide along the guide bars from one abrasive disc to the next, the samples being, if desired, rinsed in a bath 24 between each two consecutive abrasive discs. The sample holder may basically be formed like that illustrated in FIGS. 1 to 3 and is, therefore, not shown in FIGS. 4 to 7.

In the machine illustrated in FIGS. 4 to 7, both the abrasive discs and the rinsing baths are adapted to be raised and lowered relative to the machine frame 44 in a manner to be described in detail hereinafter, as indicated through arrows in FIG.4, all to the purpose of removing the abrasive disc or the rinsing bath, as the case may be, from the samples after each grinding operation or rinsing, respectively, in order to allow the samples to be passed on unimpeded. To this effect, the substantially cylindrical sample bodies 9 (FIG.3) are formed with a flange 25 at their upper ends, having a diameter greater than that of the apertures 8, so that the samples will remain suspended in the sample holder when the abrasive disc is lowered.

Each grinding or polishing unit comprises an abrasive disc 2 and a housing 1 in which the prime mover for the abrasive disc and the pivoting lever 14 is arranged. However, in this form, the housing carries no guide

bars 3, the latter being mounted in the machine frame 44, and no bracket for anchoring the rods 19 connected with the driving belts 18, this bracket being replaced by the following anchoring arrangement:

At each grinding unit 1,2 a stirrup or gallow 26 is provided which has its legs 26a slidably mounted in vertical guide sleeves 27 on the machine frame 44 which are placed on opposite sides of the slideway constituted by the guide bars 3, the gallow thus constituting an archway through which the sample holder can slide freely on the slideway. The lower end of each leg 26a is by means of a link 28 connected with an arm 29 which is secured to a transverse shaft 30 mounted in the frame 44. An actuating arm 31 is secured to the shaft and pivotable through an angle of about 90° for imparting a corresponding pivoting movement to the shaft 30 and the arms 29 about the axis of the shaft, thereby causing the gallow 26 to be correspondingly lifted or lowered relative to the frame 44.

An arm 32 extends downward from the upper transverse portion 26*b* of each gallow 26 to engage the rods 19 connected with the driving belts of the sample holder. To this effect, the anchoring means of the rods 19, FIG.1, is replaced by a pivotable latch 33 in the manner illustrated in FIG.5. The latch 33 is pivotably mounted on the pin 20*a* connecting the rods 19 and is urged upwardly to the position shown in FIG.5, to engage an abutment 34 under the action of a spring (not shown). Obviously, the latch 33 is capable of pivoting yieldably in a downward direction from this position. The rods 19 are, as illustrated in FIG. 1, formed in such a manner as to lie loosely against the upper face of the upper plate 6 in their horizontal operative positions. The arm 32 of the gallow 26 is at its lower end provided with a transverse pin 35 which, when a sample holder approaches a grinding station, engages an inclined face 36 of the latch 33 so as to urge the latter downward, until the latch clicks into anchoring engagement with the transverse pin 35. During this procedure, the gallow 26 is in its lowermost position.

For disengaging the parts from each other, in order to allow the sample holder to slide along the slideway to the next processing station, the transverse shaft 30 is turned about 90° in a counter-clockwise direction (FIG.7), whereby the gallow 26 and the arm 32 are raised to their uppermost positions and the transverse pin 35 is disengaged from the latch 33.

The transverse shaft 30 controls equally the lifting and lowering of the grinding unit 1,2 and is, to this effect, at each end provided with an additional arm 37 which is angularly spaced from the arm 29 by about 90°. As illustrated in FIG.7, the transverse shaft 30 is arranged near one end of the grinding unit 1,2, and another transverse shaft 38 is mounted in the machine frame near the opposite end of the grinding unit and has at each end an arm 39 secured thereto. Each pair of arms 37,39 are connected with each other by means of a horizontal connecting rod 40 on which the grinding unit 1,2 is supported by means of rollers 41 mounted on the housing 1. The latter is provided with vertical guiding sleeves 43 surrounding vertical guiding rods 42 secured in the machine frame 44 for vertically guided lifting and lowering of the grinding unit. Thus, when the shafts 30 and 38 are turned about 90° counter-clockwise from the position illustrated in FIG. 7, the grinding unit 1,2 is lowered while the gallow 26 with the arm 32 is lifted. In this manner, the parts 13, 14 and 32,35 are disengaged from the latches 11 and 33 so as to allow the sample holder to be conveyed along the guide bars 3 to a following rinsing bath, for example, or the output end of the machine.

The rinsing bath containers 24 may be adapted to be lifted and lowered in like manner as the housing 1, as illustrated in FIG.7. It is, therefore, to be understood that the principle illustrated in this Figure is also applicable to the rinsing bath container 24.

The actuating levers 31 of the various grinding units and rinsing baths may be individually manually operable, or they may be coupled with each other in such a manner that all grinding units and rinsing baths are lowered or lifted simultaneously. The latter possibility is especially recommendable when a plurality of sample holders are used simultaneously, one at each processing station (grinding unit or rinsing bath). The sample holders may be manually conveyed from one processing station to the next, or an automatic conveyor means may be provided for conveying the sample holders. Such conveying means may, for example, comprise a pair of endless conveyor chains arranged on opposite sides of the slideway and having fingers adapted to engage the sample holders, when the latter are to be conveyed on, and to become disengaged when the sample holder becomes latched at a processing station. If desired, the complete multi-stage grinding and polishing process may be controlled by means of a suitable program control device.

I claim:

1. A machine for grinding and polishing metallographic and mineralogic samples embedded in cylindrical sample bodies, said machine comprising a power-driven rotary abrasive disc, a sample holder mounted for reciprocatory sliding movement in a direction parallel with the abrasive face of said abrasive disc, means for imparting reciprocatory movement to said sample holder, a plurality of apertures in said sample holder, each for rotatably receiving a cylindrical sample body having one end face engaging said abrasive face of said abrasive disc, a plurality of loading means adapted to engage one end face of said sample bodies for urging said sample bodies against said abrasive face, said loading means being mounted for rotation in said sample holder about axes coaxial with said apertures, driving means for imparting alternating rotary movement to said loading means independently of frictional driving forces exerted by said abrasive disc on said sample bodies, and means associated with said loading means for transmitting said alternating rotary movement to said sample bodies.

3. A machine as in claim 1, wherein said driving means for imparting alternating rotary movement to said loading means comprise a driving connection between said loading means, said driving connection being connected with a stationary member of said machine.

3. A machine as in claim 1, comprising rectilinear guide means for said sample holder, said guide means extending parallel with the abrasive face of said abrasive disc at a distance therefrom.

4. A machine as in claim 1, wherein said means for transmitting said alternating rotary movement to said sample bodies comprises a screwdriver-tipped shaft.

5. A machine as in claim 2, wherein said driving connection between said loading means is releaseably connected with said stationary member of said machine.

6. A machine as in claim 3, wherein said rectilinear guide means comprise a pair of rectilinear guide bars arranged on opposite sides of the axis of rotation of said abrasive disc, said sample holder being provided with slide shoes partially surrounding said guide bars.

7. A machine as in claim 1, wherein said sample holder is releaseably connected with said means for imparting reciprocatory movement thereto.

8. A machine as in claim 1, comprising additional power-driven abrasive discs aligned with said abrasive disc in the direction of said rectilinear guide means, said guide means extending also over said additional abrasive discs, said additional abrasive discs being equally associated with means for imparting reciprocatory movement to said sample holder.

9. A machine as in claim 8, comprising further means for varying the distance between said guide means and said abrasive disc.

10. A machine for grinding and polishing metallographic and mineralogic samples embedded in a cylindrical sample body, said machine comprising a plurality of power-driven rotary abrasive discs having their abrasive faces substantially aligned in a common plane and their axes of rotation substantially aligned in another common plane at right angles to said first-named plane, rectilinear guide means extending parallel with both of said common planes at a distance from said first-named common plane, a sample holder mounted for sliding movement on said guide means, said sample holder having a plurality of apertures for receiving said cylindrical sample bodies for free rotation about the axes thereof while having one end face engaging the abrasive face of any of said abrasive discs, means provided in conjunction with each abrasive disc for imparting reciprocatory movement of said sample holder along said guiding means while having the sample bodies accommodated therein engaging the abrasive face of such abrasive disc, loading means having means adapted to engage one end face of said sample bodies for urging the same against the abrasive face of any of said abrasive discs, said loading means being mounted for rotation in said sample holder about axes co-axial with said apertures, and driving means for imparting rotary movement to said loading means about said axes, said driving means being adapted to be connected with an anchoring member at each abrasive disc.

11. A machine as in claim 10, wherein rinsing baths are arranged between said abrasive discs.

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