Feb. 19, 1963 W. C. COONS 3,077,706

AUTOMATIC POLISHING DEVICE FOR METALLOGRAPHIC SPECIMENS

Filed April 11, 1960

3 Sheets-Sheet 1

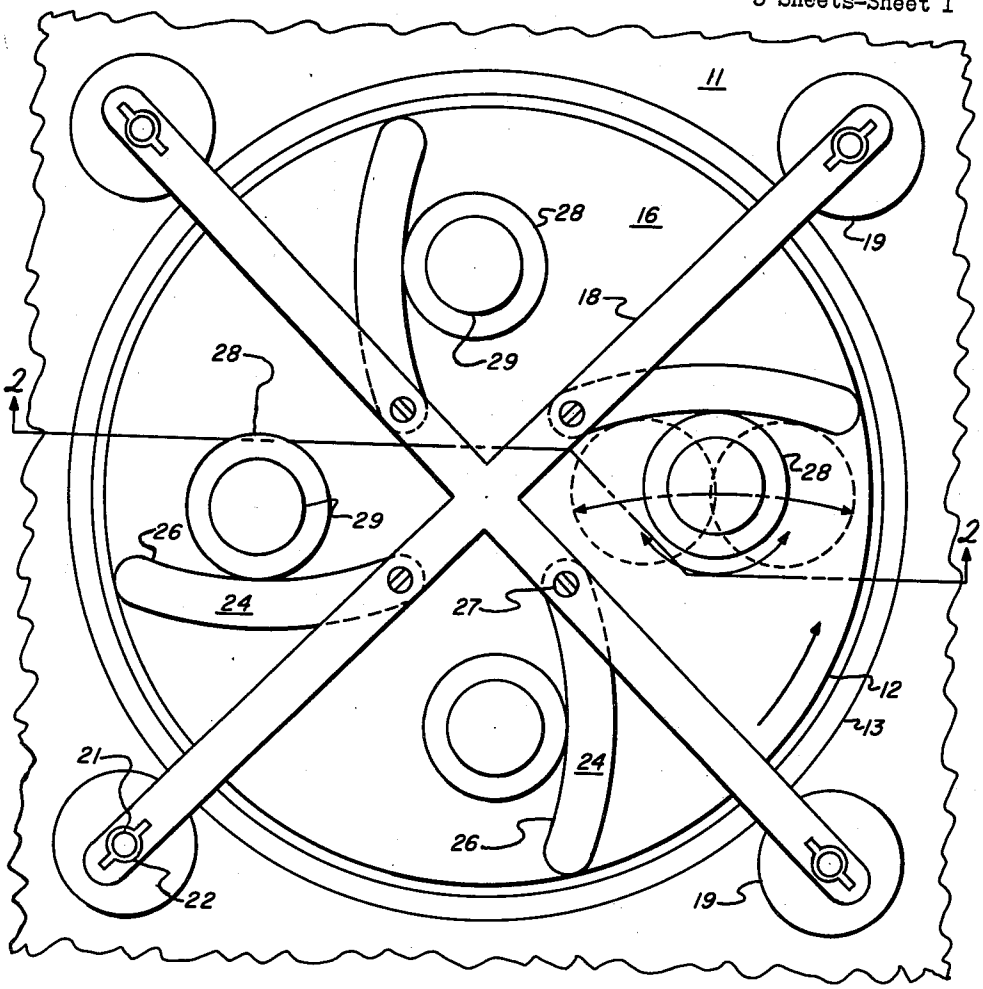


Fig. 1

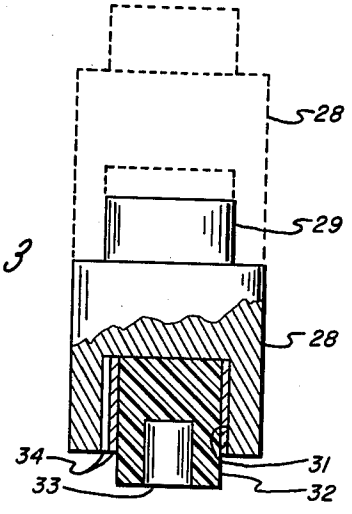


Fig. 3

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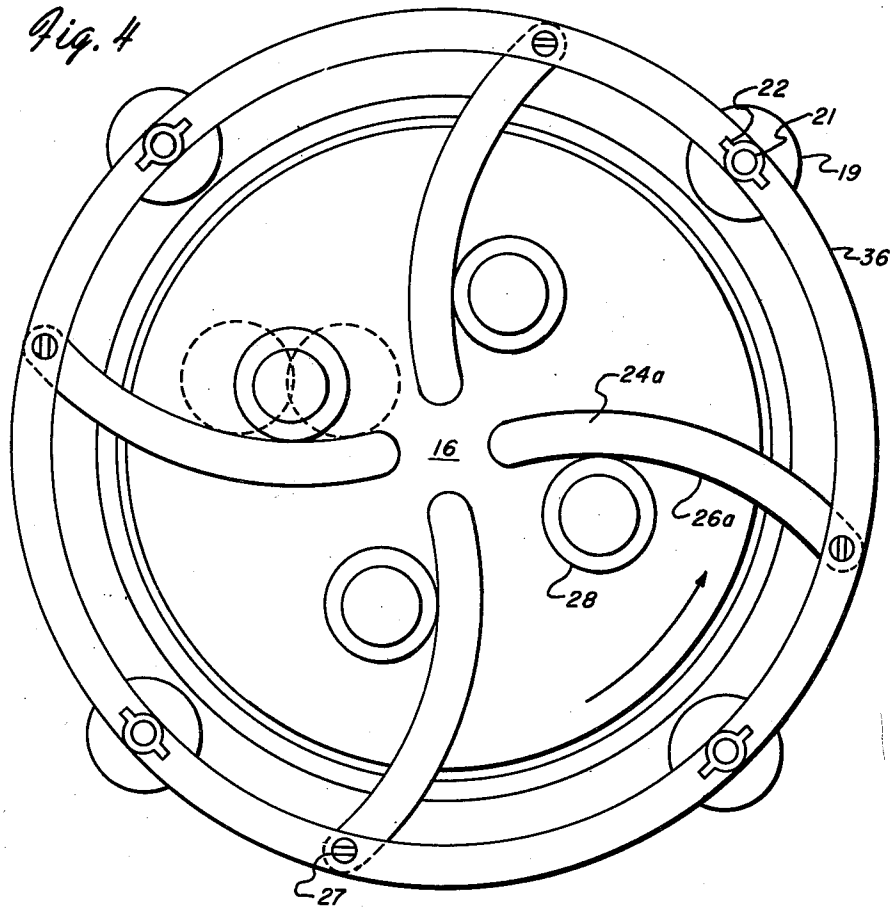
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Fig. 4



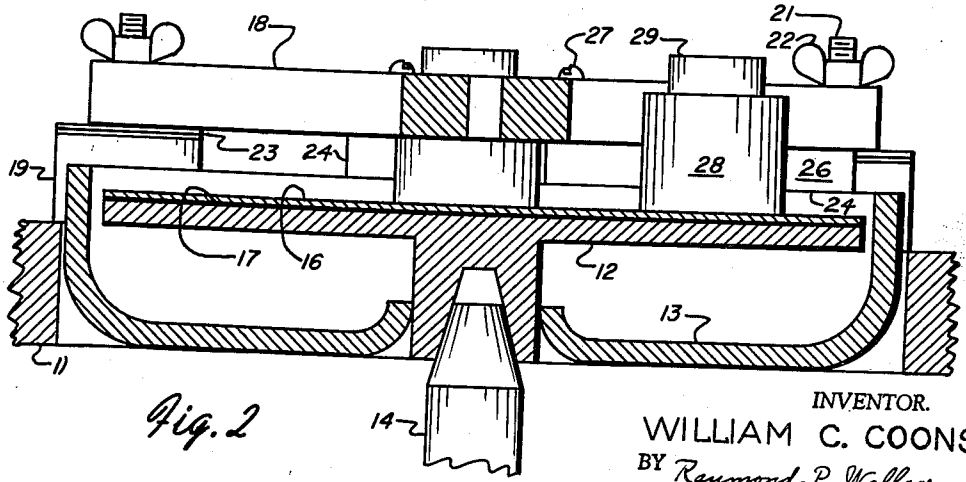


Fig. 2

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AUTOMATIC POLISHING DEVICE FOR METALLOGRAPHIC SPECIMENS

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3 Sheets-Sheet 3

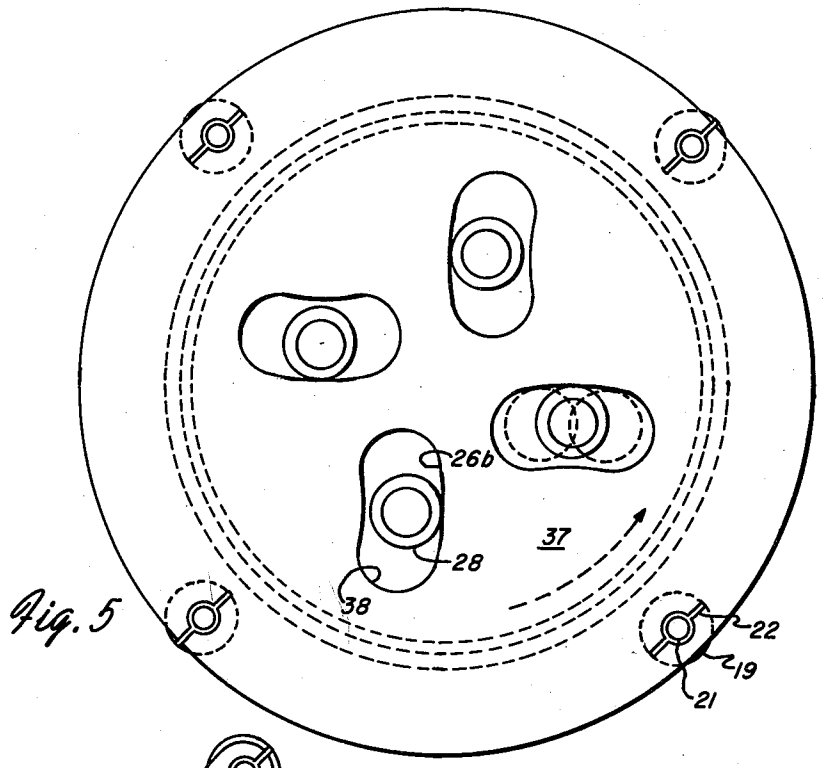


Fig. 5

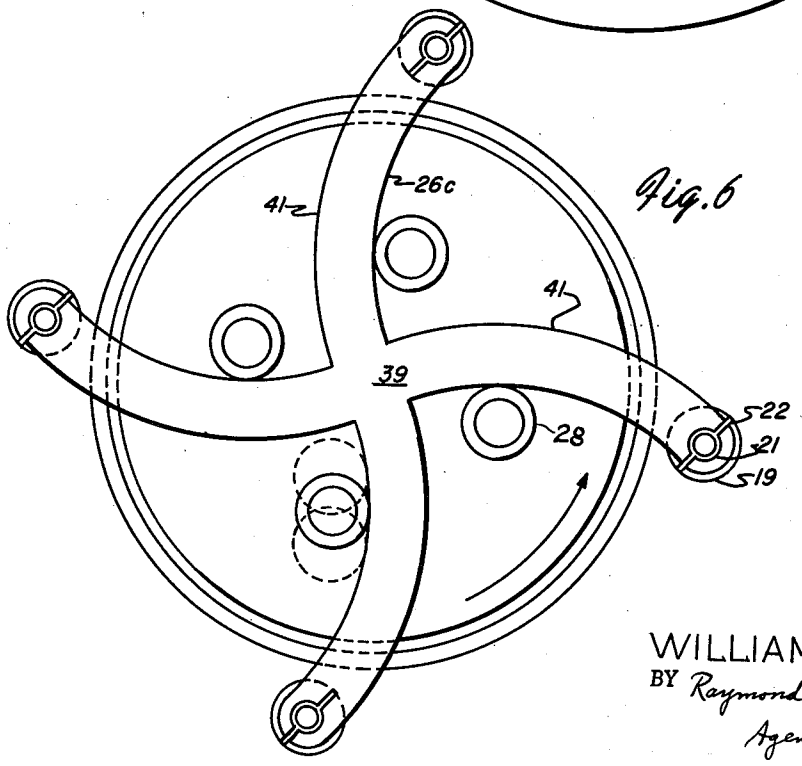


Fig. 6

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3,077,706
AUTOMATIC POLISHING DEVICE FOR METALLOGRAPHIC SPECIMENS

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This invention relates to apparatus for polishing metallographic specimens, and more particularly to an inexpensive and simplified device for automatically polishing a plurality of specimens simultaneously. The present invention may be operated by unskilled personnel, with better results and fewer difficulties than with automatic aparatus of the prior art; it is also cheaper and less complicated.

In the prior art, metallographic specimens are polished automatically as follows. Metal specimens in the form of fragments, bars, cylinders, or other shapes are imbedded in one end of a cylindrical Bakelite mount, which is then ground to a plane surface perpendicular to the longitudinal axis of the mount. A number of such mounts are then positioned in a radial holder by means of set screws, and the holder is fitted to a vertical drive shaft over a horizontally rotating wheel covered with a polishing cloth charged with abrasive compound. Spring pressure is applied to the drive post of the holder to provide firm contact of the specimens with the polishing wheel, and the holder is rotated by the drive shaft through a gear mechanism in a direction opposite to the rotation of the wheel, in order to insure even polishing.

There are grave disadvantages to this type of apparatus. It is very difficult to secure each sample by an individual set screw and still maintain all sample surfaces flat and in the same plane, which must be accomplished or else polishing will either not occur or will take place on only a portion of the sample. Also, if only one specimen is to be polished, dummy mounts must be installed in the remaining apertures of the holder in order to insure even pressure; installing the dummies is time-consuming. Further, if it is desired to inspect a specimen to determine how far polishing has progressed, the specimen must be removed from the holder for inspection, and the whole job of repositioning the set of specimens in the holder with all faces in a single plane must then be repeated before polishing can be resumed.

The polishing wheel has mounted on it a polishing cloth as a retainer for the abrasive compound. Because of the high pressures recommended with previous apparatus (from 10 to 50 pounds per sample), the cloth wears out very rapidly. It is also necessary to use slow speed wheels (about 165 r.p.m.) with such high pressures to avoid excessive wear on the polishing cloth and damage to the wheel if the cloth should become torn. Since most laboratories are equipped with high speed wheels (500–1200 r.p.m.) for hand polishing, if they wish to polish automatically they are faced with the expense of a set of slow speed wheels for several polishing stages. High pressure is an additional disadvantage in that it shortens the life of expensive abrasive compounds by knocking off the cutting edges of the particles.

In addition to its other disadvantages, the multiple specimen holder of the prior art is a complex and therefore expensive piece of apparatus, materially adding to the cost of automatic polishing. This intricacy also makes the holder very difficult to clean between successive polishing stages, so that some coarse grit is liable to be carried over and contaminate the successively finer grits on later wheels.

It is therefore an object of the present invention to provide an inexpensive device for automatically polishing a plurality of metallographic specimens simultaneously.

It is another object of the invention to provide an automatic polishing device wherein individual specimens may be examined without disturbing others.

It is still another object to provide an automatic polishing device adapted to either high speed or low speed polishing wheels.

A further object of this invention is to provide an automatic polishing device in which the samples are self-aligning.

A yet further object is the provision of an automatic polisher wherein samples oscillate across the polishing surface without being gear-driven.

Still another object is to provide an automatic polisher wherein samples can be easily cleaned between stages of polishing to avoid contamination of successive compounds with the coarser grit of previous stages.

The foregoing objects and others ancillary thereto will be readily understood on reading the following specification in connection with the drawings, in which—

FIGURE 1 is a plan view of one embodiment of the automatic polishing device positioned above a polishing wheel and in combination therewith;

FIGURE 2 is a sectional elevation taken on line 2—2 of FIGURE 1;

FIGURE 3 is an elevation, partly in section, of a sample-holding dop and auxiliary weight;

FIGURE 4 is a view similar to FIGURE 1 of another embodiment of the device positioned above and in combination with a polishing wheel;

FIGURE 5 is a view similar to FIGURE 1 of still another embodiment; and

FIGURE 6 is a view similar to FIGURE 1 of a fourth embodiment.

Referring more particularly to FIGURES 1 and 2, there is shown a fragment of the top of an ordinary laboratory bench 11 having a well therein, in which is positioned a horizontally rotatable polishing wheel 12 surrounded by a circular catch-basin 13. The basin has a center aperture through which extends a vertical shaft 14 on which the wheel is mounted, and which is driven by any convenient means, such as an electric motor (not shown). The upper surface of the wheel has a plane face on which is securely mounted a polishing cloth 16 by any suitable adhesive 17, or by other convenient means, such as clamping.

Spanning the wheel is a frame 18 which in this embodiment is shown as a four-armed spider with the center thereof approximately on the axis of the wheel. The frame may equally well have any desired number of arms, or need not necessarily be a spider but may be circular or of any other shape suitable to its function, which will now be described. The frame is borne by supports 19 which rest on the bench top and serve the purpose of holding the frame by their weight against casual movement and of spacing it at a desired height

above the polishing wheel. The supports are secured to the frame by threaded studs 21 passing through appropriate holes in the frame and wingnuts 22, or by simple smooth studs or other conventional means allowing vertical adjustment of the frame. The frame may be positioned vertically by the use of an appropriate number of washers or spacers 23 on top of each of the supports. Alternatively, the frame may be positioned on studs which rise directly from the top of the bench, or the ends of the frame may be positioned in slotted members rising from the bench-top, with suitable spacers, or any other arrangement may be employed which positions the frame above the wheel and which allows movement only in a vertical direction.

Extending from the frame are one or more oscillation guide members 24 having a concave arcuate face 26 opposed to the direction of rotation of the polishing wheel. The oscillation guide members are so mounted or otherwise attached to the frame that the concave arc is approximately normal at its midpoint to the direction of rotation of the wheel. In the embodiment shown in FIGURE 1, the oscillation guide members are generally crescent-shaped elements attached at one end to the under side of the arms of the spider frame by screws 27. Each oscillation guide member extends angularly outward from the frame in one of the quadrants defined by the arms to a point approximately over the periphery of the wheel, the outer end of the member being free, and the angle of the member being adjustable by swinging the free end to the selected orientation before tightening screw 27. The oscillation guide members may also be integral with the frame and have a fixed angular orientation without adjustment. In either case, the frame is so positioned vertically that the oscillation guide members are reasonably close to the surface of the wheel but without the possibility of any part touching the moving surface.

The concave face 26 may conveniently be made a portion of a circular arc, with a radius of curvature preferably equal to the radius of the polishing wheel, although a useful curvature may be from one-half to twice the wheel radius.

The material of the frame and oscillation guide members may be anything suitable for forming the parts, no great strength being required. Plastic has been found satisfactory, as the parts may be fashioned separately, or a unitary piece embodying both frame and oscillation guide members may be molded. Metal is also suitable and may be either machined or cast, or wood may be used. Supports 19 may be of any convenient form and suitable metal having adequate mass, although it is not necessary that they be of lead, since the displacing forces on the frame caused by operation of the device are relatively minor; brass has been found to be satisfactory. It is also unnecessary that the support members should rely on weight to keep the frame from being displaced. It has been found satisfactory to make the supports of plastic or wood and provide the bottom with an adhesive coating, such as a double adhesive tape, to hold them to the bench.

There is provided a plurality of rotatable dops 28, best shown in FIGURE 3. The dops are of generally cylindrical form, and it has been found convenient for them to have the closed or upper end 29 made of reduced diameter of such size as to fit conveniently within the chamber in the lower end of another dop, in the event that it is desired to stack a second dop on top of the first for added weight, as shown. Each dop contains an axial cup or recess 31 in its bottom face, adapted to receive a specimen mount 32 bearing embedded therein the metallographic specimen 33 to be polished. The blind end or inner face of recess 31 is made substantially normal to the axis of the dop, in order that it should not rock in operation. The specimen is here shown as cylindrical, but may be of any other shape, as is well known in the metallographic art. The cylindrical specimen mount is made of somewhat smaller diameter than that of the recess, and the mount is held in place in the recess by a resilient shim 34 comprising a strip of thin springy material circularly wound and inserted into the cavity where it is allowed to expand and bear against the cavity wall. The shim should be of such length as to allow some overlapping of the ends when in place in the cavity, and thus by a slight deformation from circularity to grip the mount securely.

The dops may be of more or less height, according to the amount of weight desired, and should preferably be made of non-corrodible metal such as stainless steel, but may also be of plastic, porcelain, or other material. The springly shim is also preferably stainless steel, but may be made of stiff plastic.

In the operation of the automatic polishing device in combination with a polishing wheel, the specimen is first embedded in a plastic or Bakelite mount, according to standard practice. The shim is installed in the recess in the dop and the mount is pressed into place with the face bearing the specimen protruding slightly. The frame is positioned over the wheel and any number of dops from one up to the capacity of the device are placed with the specimen in contact with the polishing cloth and the cylindrical surface of each dop bearing against the curved face 26 of one of the oscillation guide members. The wheel is set in motion and the dops are restrained from traveling with it by the oscillation guide members. However, each dop librates or oscillates back and forth across a portion of the diameter of the wheel as shown in FIGURE 1, the cylindrical surface of the dop rolling against curved face 26, whereby the polishing cloth wears evenly across the wheel and the specimen is not polished wholly in one direction, as would be the case if no oscillation occurred.

Such libration is in effect a pendulum oscillation in which the amplitude of swing does not decay. The libration of the dops is not noticeably affected by any change in the speed of the wheel within the range useful for automatic polishing, that is, about 100 to about 1300 r.p.m. Neither is the precise angle of the curved face 26 to the diameter of the wheel critical when an oscillation guide member with a radius of curvature equal to the radius of the wheel is used. The optimum orientation is with the center of the curve 26 approximately normal to the direction of rotation of the wheel, whereupon the dops librate to an equal distance in each direction from the center. If the free end of the oscillation guide member is swung upstream of the rotation, libration will occur on the more inward portion of the libration member and therefore toward the center of the wheel; if the free end is swung downstream, libration will occur toward the periphery of the wheel and on the more outward portion of the oscillation guide member. The limits of such adjustment are about ten degrees in either direction; if the angular displacement of the oscillation guide member is too great, the dop will lodge either against the spider arm or the rim of the catch basin, depending on the direction of adjustment. When an oscillation guide member with a smaller radius of curvature is used the length of the oscillation path will be shorter, and when an oscillation guide member with a longer radius is used the path will be longer. In either of the two latter cases the allowable angular adjustment is less than when using a libration member of curvature approximately equal to the radius of the wheel.

In FIGURE 4 there is shown another embodiment of the invention in which the only significant change is the shape of the frame element supporting the oscillation guide members. In this embodiment the frame 36 is a member which spans the wheel by surrounding it rather than passing across it, and which supports the oscillation guide members. The frame may be circular as shown, or square, hexagonal, octagonal, or of other desired shape such that it will surround the wheel. Frame 36 is

shown resting on supports 19 on the bench, but it may also be positioned in any of the ways applicable to the previous embodiment. Crescent-shaped oscillation guide members 24*a* are mounted at one end on the under side of the frame by screws 27 as in the previously described embodiment, and extend inwardly of the frame with concave arcuate faces 26*a* opposed to the direction of rotation of the wheel. The arcuate faces shown are of the same radius as the polishing wheel, and the oscillation guide members are so disposed that the curve of the arc is tangent to the radius of the wheel at a point substantially ½*r* from the center of the wheel, the arcuate faces having sufficient inward extension to allow a suitable libration path for the dops. The angle made by the oscillation guide members to the direction of rotation is adjustable by swinging the free ends, which in this embodiment are the inner ends, of the members before tightening screws 27, and the useful limit of such angular adjustment is about ten degrees in either direction. Although the oscillation guide members of this embodiment are shown as having an overall crescent shape for convenience in manufacture, it is immaterial what shape the downstream edge of the members have, just as in the previously described embodiment, so long as that edge does not interfere with the librating movement of the succeeding dop. Likewise, it is not necessary that the curvature of the arcuate face be prolonged beyond the periphery of the polishing wheel. It will be evident that in this embodiment the oscillation guide members may be mounted on the top of the circumferential frame if desired, whereby the frame itself may be positioned lower than in the case of embodiments wherein the frame crosses the wheel.

In this embodiment there is provided a plurality of dops 28 which oscillate against the curved faces 26*a* as already described. If desired, the oscillation guide members 24*a* may be made integral parts of the frame 36 without angular adjustability. Suitable materials for the frame and oscillation guide members are the same as in the previous embodiment.

FIGURE 5 shows an embodiment of the invention in which the frame and oscillation guide members are combined in a single element. There is provided a frame comprising a plate 37 formed of any of the materials previously described as suitable, large enough to span the polishing wheel, and resting on supports 19 as before. Although plate 37 is shown as circular in form, it may be of any other appropriate shape, such as square, hexagonal, octagonal, etc. The plate is provided with apertures 38 comprising oscillation guides, each of such apertures having a portion thereof formed into a concave oscillation face 26*b* having a radius of curvature approximately equal to the radius of the polishing wheel and so disposed that the center of the arc is tangent to the radius of the wheel as a point substantially ½*r* from the center of the wheel, with the concavity opposed to the direction of rotation. The apertures are of such size that dops may conveniently be inserted therein and librate against faces 26*b* along an oscillatory path such as previously described. The shape of the ends and upstream edges of the apertures is immaterial, as long as they do not interfere with the movement of the dops. It will be apparent that plate 37 will usually be positioned closer to the surface of the polishing wheel than the previous frames, since in this case the oscillation guide members are not mounted on the bottom of the frame but are part thereof and in the same horizontal plane. The plate-frame may also have more or less apertures having oscillation guide faces than the four shown.

FIGURE 6 shows another embodiment in which the frame and oscillation guide members are combined. There is provided a plural-legged member 39, an ogee tetraskelion being shown, having legs 41 radiating from a central point of origin which in operation is positioned over the center of the polishing wheel. Legs 41 present concavely arcuate oscillation guide faces 26*c* opposed to the direction of rotation of the wheel, and the arc of each such oscillation guide face has a radius approximately equal to the radius of the wheel and is so disposed that the arc is tangent to the radius of the wheel at a point substantially ½*r* from the center of the wheel. Although the downstream faces of the legs are shown curved, it is immaterial what shape they have as long as they do not interfere with libration of the dops. The tetraskelion rests upon supports 19 as before, but may be otherwise positioned in any convenient manner at such distance above the wheel as to allow the dops to librate readily against faces 26*c*. Although the plural-legged member is shown as a tetraskelion, it may also have any other convenient number of legs, such as a diskelion, triskelion, etc.

In the embodiments described herein the polishing wheel is shown in each case as being rotatable in a counterclockwise direction. It will be apparent that in the case of a clockwise wheel the invention can be easily adapted by reversing the direction of the concavity of the oscillation guide members, so that the said concavity is always opposed to the direction of rotation of the wheel.

Although the invention has been described in a preferred form, it will be understood by those skilled in the art that various changes and modifications can be made without departing from the scope of the invention. It is intended to cover all such modification in the appended claims.

What is claimed is:

1. In an automatic polishing device having a rotatable polishing wheel with a vertical axis and a horizontal polishing surface, the combination with said wheel of at least one oscillation guide member disposed above said wheel and substantially parallel with the surface thereof, said oscillation guide member having a concavely arcuate face with a radius of curvature approximately equal to the radius of said wheel, said arcuate face having the concavity thereof opposed to the direction of rotation of said wheel and being approximately tangent at its midpoint to the radius of said wheel, and at least one generally cylindrical dop adapted to hold a metallographic specimen and positioned on the polishing surface of said wheel with the axis of said dop parallel to the axis of said wheel, said dop having its cylindrical surface in frictional contact with said arcuate face and being in oscillatory relation thereto along a path parallel to said face.

2. In an automatic polishing device having a rotatable polishing wheel with a vertical axis and a horizontal polishing surface, the combination with said wheel of a frame member spanning said wheel and having at least one oscillation guide member extending above the surface of said wheel substantially parallel with the surface thereof, said oscillation guide member having a concavely arcuate face with a radius of curvature approximately equal to the radius of said wheel, said arcuate face having the concavity thereof opposed to the direction of rotation of said wheel and being approximately tangent at its midpoint to the radius of said wheel, and at least one generally cylindrical dop adapted to hold a metallographic specimen and positioned on the polishing surface of said wheel with the axis of said dop parallel to the axis of said wheel, said dop having its cylindrical surface in frictional contact with said arcuate face and being in oscillatory relation thereto along a path parallel to said face.

3. In an automatic polishing device having a rotatable polishing wheel with a vertical axis and a horizontal polishing surface, the combination with said wheel of a frame member positioned above said wheel and extending thereacross substantially parallel with the surface thereof, said frame comprising a plurality of legs radiating outwardly from a common center, each of said legs having one edge thereof comprising an oscillation guide

member having a concavely arcuate surface with the concavity thereof opposed to the direction of rotation of said wheel, said arcuate face having a radius of curvature approximately equal to the radius of said wheel, said frame being positioned with its center approximately on the axis of said wheel whereby said arcuate faces are substantially tangent at their midpoints to radii of said wheel, and a plurality of cylindrical dops each adapted to hold a metallographic specimen and positioned on the polishing surface of said wheel with the axes of said dops parallel to the axis of said wheel, each of said dops

having its cylindrical surface in frictional contact with one of said arcuate faces and being in oscillatory relation thereto along a path parallel to said face.

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