May 7, 1946. R. HAYWARD 2,399,924

DEVICE FOR GRINDING AND POLISHING SURFACES

Filed Feb. 17, 1945 3 Sheets-Sheet 1

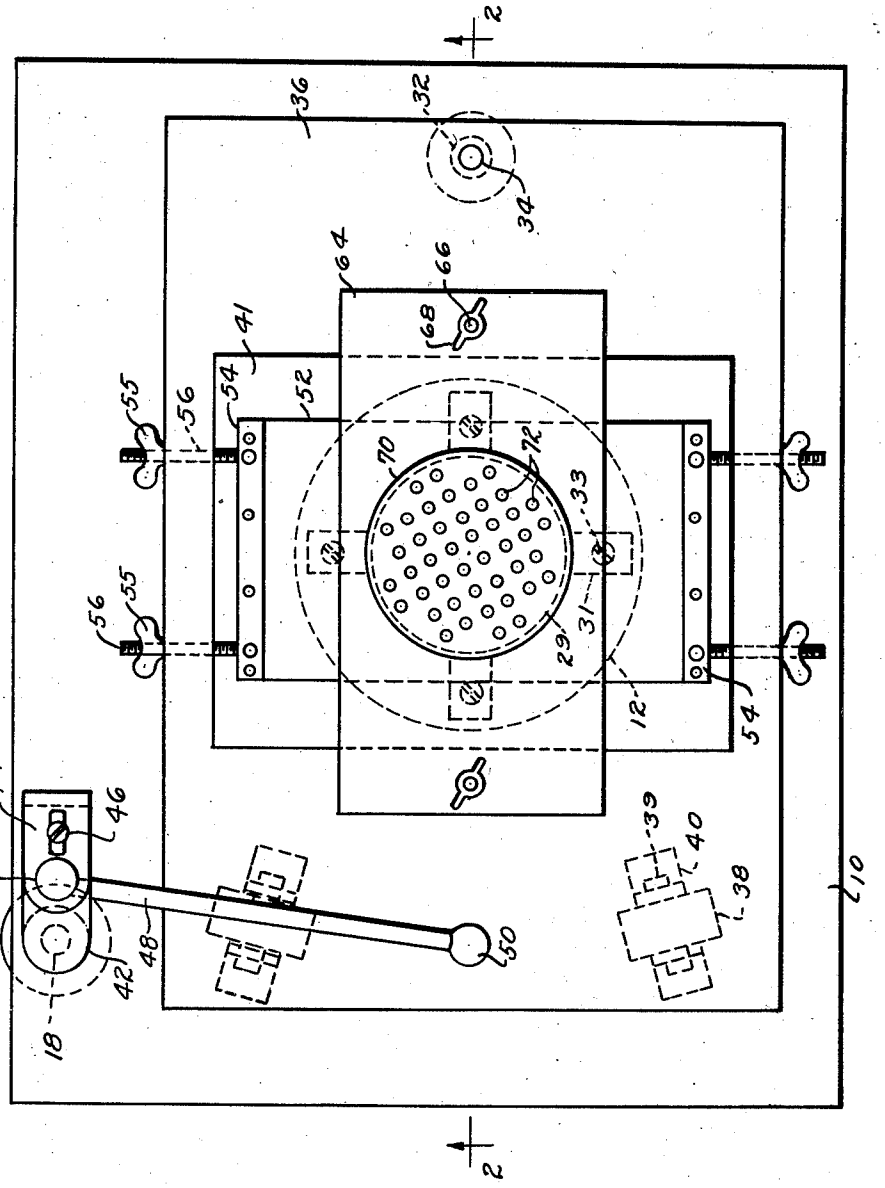

FIG. 1.

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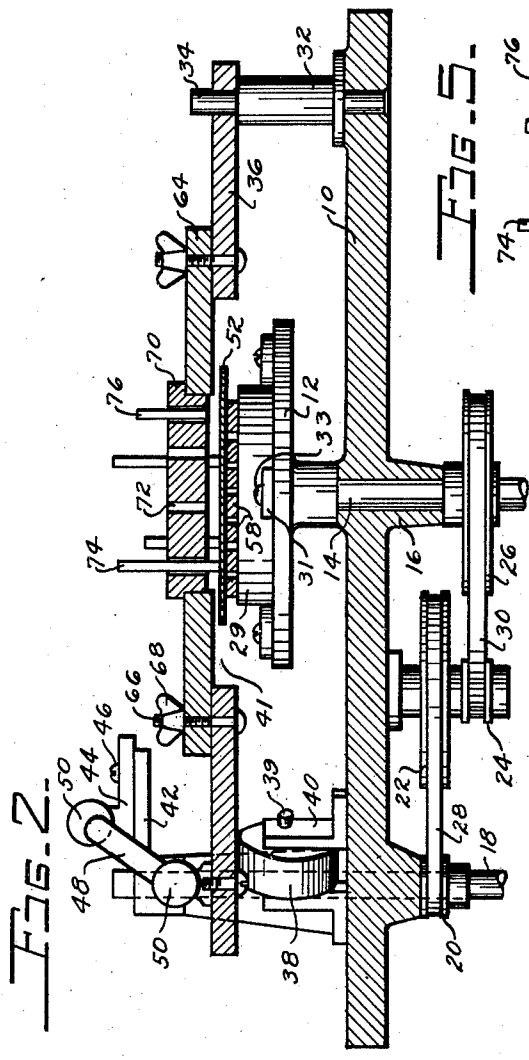

FIG. 2.

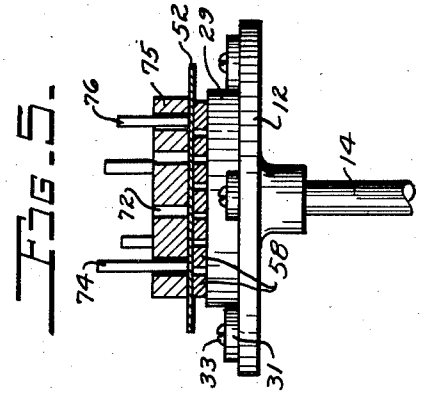

FIG. 5.

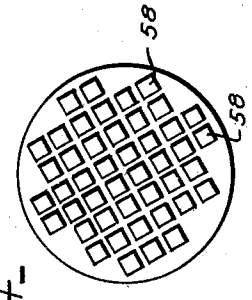

FIG. 4.

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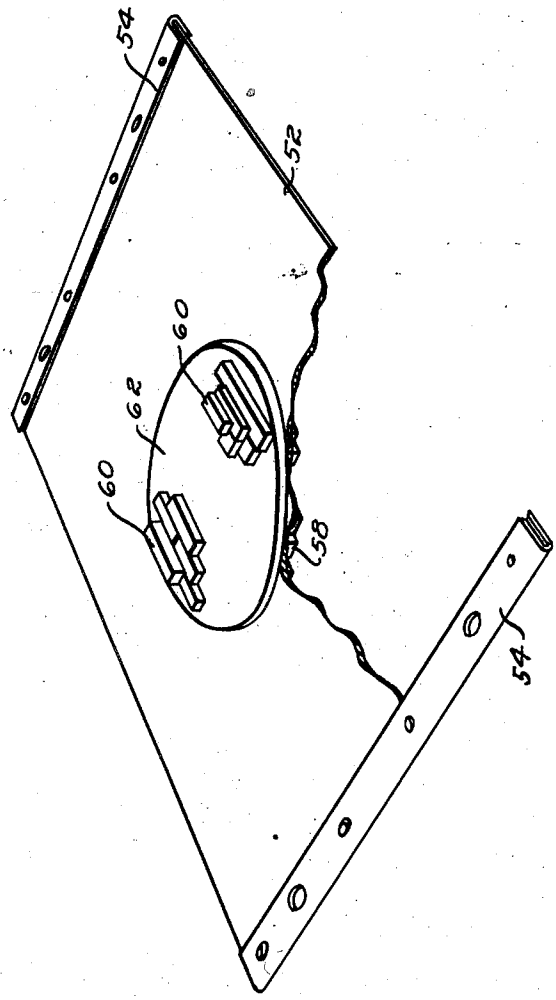

Fig. 3.

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UNITED STATES PATENT OFFICE

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DEVICE FOR GRINDING AND POLISHING SURFACES

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Application February 17, 1945, Serial No. 578,459

9 Claims. (Cl. 51—185)

This invention relates to a device for grinding and polishing surfaces and is particularly applicable to that system of grinding and polishing which involves relative movement of rotation and translation between the work and the tool, usually with some kind of abrasive between them. This system is used extensively in grinding lens, reflectors, and devices having similar surfaces of revolution.

In this system the relative movements may be accomplished either manually or by means of machinery well known in the art, the material, the relative size and form of the tool and the abrasive used between the tool and the work depending generally on wether grinding or polishing is being effected. Broadly speaking, the device herein proposed is applicable to all such variations and uses, but is especially effective in performing the polishing operations of final figuring of a surface because of the inclusion of means whereby close control may be exercised over the rate at which material is removed from predetermined zones on the surface as compared to the rate of removal from adjacent areas.

In the art as heretofore practiced, the tool has been of a relatively rigid and inflexible nature, and, although the tool may be made smaller than the work, or, in a faceted tool, some of the facets may be omitted or removed, thus enabling grinding or polishing operations to be selectively applied to limited portions of the work surface, yet at no time in the past has it been proposed to associate with the tool any means whereby the pressures on selected areas of the tool may be varied at will.

As part of the development of the present invention in its relation to the grinding of lens or mirrors, an investigation was made of the relation between the rate of glass removal and the pressure applied to the tool. This investigation indicates that the rate of removal of glass in polishing operations is a linear function of the pressure up to pressures of about 18 oz. per sq. in., and the indications are that, in grinding operations, the upper limit of that linear relationship is probably higher. In both of the polishing and grinding operations, therefore, the rate of glass removal at any part of the surface of the work may be accurately controlled by control of the applied unit pressure. Since tests and measurements of the work in progress indicates the zones or areas at which removal may preferably proceed at a faster or slower rate, it is an object of this invention to provide a tool in which the unit pressures over the face of the tool may be accurately controlled, to the end that the pressures may either be made uniform over the whole face of the tool if so desired, or be made to vary over the face in conformance with a pressure pattern which has been determined from inspections and measurements of the work.

The new tool which is the subject of this invention is thus advantageous not only in operations which require localized correction of a surface to bring it to the required figure, but also, because of its flexibility, has advantages, for instance, in final polishing operations on the more irregular surfaces such as the surfaces of revolution of Schmidt correcting plates, even though the final polishing operations merely involve uniform removal of glass from the surface without changing its figure.

While the new device is applicable to both hand and machine grinding and polishing, the embodiment selected to illustrate the invention is described and shown in an application of the tool to a typical grinding and polishing machine.

In the drawings:

Fig. 1 is a top plan view of a typical lens grinding and polishing machine with the improved tool applied.

Fig. 2 is a longitudinal-vertical section taken at 2—2 of Fig. 1 showing the tool in axial section.

Fig. 3 is a perspective view of the tool as it appears when removed from the machine, this view showing one manner of loading the tool to provide localized pressure of preselected degree to predetermined surfaces, a portion being broken away to show parts on its underside.

Fig. 4 is a bottom view of a part of the tool showing the arrangements of the facets.

Fig. 5 shows a variant of the weight distributing arrangement shown in Fig. 2.

Mounted on the supporting platform 10 of the machine is a work table 12 which is rotatable on a journal shaft 14 in bearings 16. A power shaft 18, preferably driven by some suitable power source is drivably connected to the shaft 14 through pulleys 20, 22, 24, and 26 and belts 28 and 30, whereby the work table 12 is driven at a relatively low speed as compared to the power shaft 18. The work, in the embodiment shown, consists of a disc 29 held to the work table 12 by clamps 31 adjusted by screws 33.

A post 32 extends upwardly from the platform 10 and carries, at its upper end, a pivot 34 upon which a tool supporting frame 36 is oscillatable. Rollers 38 rotatably supported on a pin 39 in brackets 40 carried on platform 10 engage the

underside of the frame 36 at the free end to maintain its horizontal position under oscillation.

Fixed to the upper end of the power shaft 18 is a crank 42 which carries a bracket 44 which is radially adjustable upon loosening the screw 46, whereby the throw of the crank is adjustable. A connecting rod 48 having ball and socket joints 50 joins the crank bracket 44 to the frame, whereby rotation of the power shaft 18 oscillates the frame in a horizontal plane. The portion of the apparatus thus far described pertains to the grinding and polishing machine and is more or less conventional, that portion following being directed to the novel tool per se.

The mid portion of the frame 36 is cut away as at 41 and a flexible membrane 52 is stretched transversely across the opening in the direction of its oscillations. This membrane may be of any suitable flexible material, preferably nonextensible in the direction in which dragging stresses are applied to it by the oscillatory movement. A thin rubberized fabric may be used and the edges of the membrane may be bound at the ends by metal strips 54 which carry studs 56 each having one end anchored in the strips 54 and the free end extending through the frame. Wing nuts 55 on the studs 56 are employed to stretch the membrane 52 across the opening and adjust its tension when required. The membrane is usually adjusted to just enough tension to prevent wrinkling by the dragging forces of the grinding or polishing facets which are secured to its underside.

Grinding or polishing facets 58 are attached in a spaced pattern to the underface of membrane 52. A conventional pattern is shown in Fig. 4, the facets, however, in conventional practice being attached to a rigid base, and not to a flexible base as in the disclosure herein. The material of the facets may be various, for instance, for grinding operations they may be of unglazed tile, or of a porous metal such as cast iron, or of the same material as the material of the work. For polishing operations pitch facets are preferably used. The facets may be attached to the membrane with an adhesive wax. The spacings between the facets should be wide enough to allow the necessary flexibility of the facets and membrane unit to follow the curvature of the work, and the position of the membrane should be far enough above the work that the facets just touch the work in the normal unweighted position of the membrane. The length of the membrane between its supported ends may preferably be several times the diameter of the work to insure that any vertical vibrations or the vertical deflection of the facets in following the curvature of the surface of the work or any deviations of frame movement from a plane parallel to the work surface, will have no appreciable effect on the pressures exerted by the facets on the work.

The facet area may be selectively weighted in a number of different ways. In Fig. 3, preselected groups 60 of weights are wrapped in scotch tape and positioned in predetermined zones over the facet area. The groups 60 may be placed directly on the membrane 52 or they may be placed on a disc 62 of sponge rubber which is centered over the facet pattern. The sponge rubber pad serves to somewhat distribute the weight forces over adjacent facets.

Another weight distributing arrangement is shown in Figs. 1 and 2 where a weight carrier 64 extends across the opening 41 in the frame 36 and is held in position thereon by bolts 66 and nuts 68. A centrally disposed opening in the carrier locates a weight spacing block 70 slightly above the diaphragm and over the facet area. Perforations 72 in the block 70 are of a size to receive weights 74 and 76 loosely. The weights may be of different heights and therefore of different masses, and, if desired, the perforations in the block may be arranged in the same pattern as the pattern of the facets so that each weight being used will be applied to a single facet.

In any particular case, the selection and distribution of the weights, either when arranged as in Figs. 1 and 2 or when arranged as in Fig. 3 will depend upon the particular change in shape which it is desired to bring about by the grinding or polishing operation. If some particular grinding or polishing job is to be repeated a considerable number of times, and the proper selection and distribution of the weights has been ascertained for that particular job, a pad like that shown at 62, Fig. 3, may have its properly placed weights waxed to it so that the unit may thereafter be used separately.

In the arrangement shown in Figs. 1 and 2, a chart or a tabulation of the weights and their distribution in the spacing block may be made up after the weight selection and distribution for a given job has been determined, whereby the resetting of the same weight distribution for a similar job will be facilitated.

Instead of supporting the weight spacing block 70 on the carrier 64 as shown in Figs. 1 and 2, a block 75 may be supported as in Fig. 5, that is, directly on the membrane 52 by an adhesive, or the underside of the block may be faced with a material which sufficiently adheres to the membrane to prevent its displacement in operation.

While the several views of the drawings may indicate that weight distribution is had by placing weights in some areas and none in others, it will be understood that the unequal distribution desired may be had by loading the entire area with weights some heavier than others.

While the description and drawings disclose the invention as applied to a common form of grinding and polishing machine, it will be apparent that the device may also be adapted to hand grinding, but the matter of whether the relative movements required are produced by machine or by hand or the nature of these relative movements, are immaterial to the invention. The flexibility of the tool enables its facets to follow the curvature of any surface if it is not too far from the flat and at the same time permits and facilitates the selective application of forces to predetermined portions of the facet area.

If weights of the same mass are uniformly applied over the whole area, then all of the facets will tend to bear with equal force on the work surface and to follow that surface during the relative movements, the tendency then being to grind and polish evenly over the whole work surface. If, on the other hand, the weight distribution is non uniform, localized concentration of grinding or polishing will result.

Having shown and described an embodiment of the invention and variants thereof, I claim:

1. A polishing or grinding device for finishing surfaces, which comprises a stretched flexible substantially nonextensible diaphragm, a flexible abrasive-carrying tool attached to one diaphragm face, a rigid frame to which the periphery of the diaphragm is attached and means for applying

adjustably varying pressure to selected points on the other diaphragm face opposite the tool.

2. The device of claim 1 in which the means for applying adjustably varying pressure to selected points consists of a series of weights of varying capacity with means for maintaining them in selected positions on the said other diaphragm face.

3. The device of claim 1 with a pressure distribution pad interposed between the diaphragm and the pressure applying means.

4. A device as in claim 1 in which the pressure applying means consists of a series of weights and a pressure distributing pad between the diaphragm and the weights.

5. A polishing or grinding device for finishing surfaces, comprising a tool which includes an array of discrete surface engaging facets normally lying in a plane, flexible interconnection between the facets allowing the facet array to flex from the normal plane, said flexible interconnection comprising a stretched flexible diaphragm to which the facets are attached and a rigid frame to which the periphery of the diaphragm is secured, and means for selectively applying pressure to selected areas of the facet array.

6. The device defined in claim 5 in which the means for selectively applying pressure consists of a plurality of weights.

7. The device defined in claim 5 in which the means for applying pressure comprises a pressure distributing pad resting on the flexible diaphragm and weights resting on the pad.

8. The device defined in claim 5 in which the means for applying pressures comprises a weight spacing member resting on the diaphragm and having weight receiving openings extending vertically therethrough, and weights in the openings of the spacing member bearing on the diaphragm.

9. The device defined in claim 5 in which the means for applying pressures comprises a weight spacing member supported above and slightly spaced apart from the diaphragm and having weight securing openings extending vertically therethrough, and weights in selected openings of the spacing member bearing on the diaphragm.

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