This invention relates to a machine for grinding the edges of blanks of glass or other grindable material to a predetermined contour. More particularly it has relation to a machine of that type for grinding the edges of optical lenses.

In the manufacture of eyeglasses, great variety in the contour of the finished lenses is encountered, these being circular, oval, pear-shaped, etcetera. After having been ground to prescription upon its faces, the lens is rough-cut to approximate peripheral outline and then ground to the finished contour. Sometimes the edge-grinding is performed before the surface-grinding, the order of these two phases of the operations being immaterial in so far as the subject invention is concerned.

Grinding of the edges of the lens is normally done with the aid of a template, this being usually a flat piece of metal formed on its periphery to a predetermined outline whereby a follower adapted to bear thereagainst may, during joint rotation of the template and glass blank, regulate the position of the blank to the grinding wheel at all positions of such rotation to cut the lens to finished form. Frequently it is desirable, when matching a new lens to replace a broken one of a pair, to use the unbroken lens as the template.

Machines for performing the operations aforesaid are well known, but in so far as my experience has demonstrated, all suffer from lack of ease and flexibility of adjustment, are unduly complicated for the performance of a relatively simple operation, and are incapable of a high rate of production. For example, best practice directs a rough-grinding operation followed by a finish grind, and in present machines transition from one grinding wheel to the other, or the shifting of the blank from one part to the other of a two-part wheel, is slow and cumbersome.

Having in mind the foregoing and other factors, the principal object of my invention is the provision of a machine for edge-grinding, particularly lens edge-grinding, which is compact, possesses few parts, and is capable of simple and rapid adjustment to meet the variety of work entrusted to such machines.

Another important object is to provide a machine as aforesaid in which the template and blank are supported for joint rotation on a common axis, the latter being oscillatable about a shaft which constitutes the main drive shaft.

A further object is to provide improved means for holding the template which is positive and accurate during the grinding operation but is capable of rapid unlocking to release the template and to load a different template.

Still another object is to provide improved means for gripping the blank positively during the grinding operation but which is adapted to be rapidly disengaged for removal of the finished blank and insertion of the next piece of work.

Another object is to so arrange the parts as to allow an unimpeded working zone to facilitate inspection of the work in progress, and to permit easy access to the work-holding means.

For lenses having varying transverse dimensions but the same general contour, it is possible to use the same template, but in such cases the position of the follower relatively to the oscillatable work-head must be adjusted. Present machines are impractical in this respect, as the adjusting means is not easily accessible and the adjustment is subject to disturbance during grinding.

Accordingly a further object is to provide simple and easily accessible means for adjusting the position of the template follower, which once set is not capable of slipping out of adjustment.

An additional object resides in the provision of conveniently positioned, rapidly movable means for shifting the blank from rough-grinding to finish-grinding position.

Another object is to provide a machine as aforesaid in which a single handle is provided for holding the oscillatable head forwardly while loading the blank, and for operating the blank clamping means, thus leaving the other hand free for placing the blank in position and eliminating the necessity of a separate latch for maintaining forward position of the head.

In the drawings, which show one form of carrying the invention into effect:

Fig. 1 is a cross-sectional view taken substantially in a plane passing through the axes of the lens and template spindles and the power shaft;

Fig. 2 is a plan view partly in cross section;

Fig. 3 is a cross-sectional view taken substantially on the line 2—2 of Fig. 1;

Fig. 4 is a cross-sectional view taken substantially on the line 4—4 of Fig. 1;

Fig. 5 is a perspective view of a portion of the template follower and certain parts associated therewith;

Fig. 6 is an exploded perspective view of portions of the template and lens carrying spindles;

Fig. 7 is a cross-sectional view of an alternative template holding arrangement when a lens is used as the template; and
Fig. 8 is a detail in perspective of an alternate construction for holding a metal template. The machine comprises a framework 10 of box-like construction having side walls 11 and 12, a front wall 13, a rear wall 14, and a top wall 15 to provide a rigid, yet light, base and support for the parts to be detailed. Attached by screws 18 to the walls 11 and 12 are the flat supports 19—19 in turning carry the gibbs 22—22 attached thereto by screws (not shown). Sizable intermediate gibbs 22—22 is the plate 23 having an ear 24 into which is threadedly engaged the belt-tensioning adjusting screw 25 accessible exteriorly of the wall 14, and the head of which is retained in shouldered aperture 26. A combined electric motor and speed reducer 21 of a common type is fastened to the plate 23 by screws (not shown), the output shaft 29 whereof has a grooved pulley 30 affixed thereto. A V-belt 32 passes over the pulley 29, the tension of the belt being regulated by screw 25 in an obvious manner. Belt 32 extends upwardly through an aperture 33 and passes over a grooved pulley 34 to be detailed hereinafter.

Walls 13 and 15 meet in an offset at the front of the plate 13 to form subwalls 35 and 36, the latter having pads 39—39 at the ends thereof whereon bearings 41—41 are mounted. Rotatable in bearings 41—41 is the main or power shaft 42 retained axially in one direction by a head 43 thereof, and in the other direction by a stop collar 44. Pulley 34 is keyed to shaft 42 by a pin 45 and is provided on its right-hand face with an integral cam surface 46. Oscillation of the work-carrying head, to be described, is effected by a sleeve 51 having an aperture 52 by means of which the sleeve and the parts associated therewith may slide axially with respect to shaft 42. Sleeve 51 has an integral cam-following projection 53, and further is united by an arm 50 and screws 55 to an eccentrically-positioned sleeve 54.

The work-carrying head 60 comprises a rigid frame 61 having a pair of depending arms 62 and 63 including apertures 64 and 65 permitting oscillatable and slidable movement of the head 60 with respect to the shaft 42 as the template is moved against its fixed follower and the head is reciprocated from left to right. Such horizontal reciprocating movement of the frame 61, for moving parts also oscillating as a whole in order that the template may, by maintaining contact with a fixed follower, cause the blank to be ground to a predetermined contour as controlled by the outline of the template.

Referring particularly to Figs. 1 and 6, the lens blank 91 is gripped between a pair of resilient annular pads 93 and 94, e. g., of rubber, cemented to carrying discs 95 and 96 respectively. The latter are each provided with a pair of diametrically-opposed apertures 97 and 98 respectively, snugly to receive pairs of pins 101 and 102 affixed to chucks 103 and 104 respectively. The parts just described are conventional in lens edge-grinding machines, and further amplification is deemed unnecessary.

Chuck 106 is pivoted to fit snugly over pilot 109 integral with the spindle 101 of the live center 108, the spindle bearing within a sleeve 109, and is provided further with apertures 104 fitting pins 103 in live center 108. Live center 108 is of conventional construction and includes thrust ball 111 and retaining screw 112 therefor. A sleeve 113 receives the live center 108 with a tapered press fit, and a compression spring 114 retained by an adjustable knurled head screw 115 serves to urge sleeve 113 and center 108 to the left. Screw 115 is threadedly engaged in an end plate 116, as shown by screws 117 secured to a housing 118 formed as an integral part of the frame 61.

Sleeve 113 is provided upon the lower portion of its periphery with rack teeth 121 engaged by a pinion 122 affixed to a shaft 123, the latter being rotatable in housing 118 and having a handle 124 (Figs. 2 and 3) secured thereto.

Chucks 103 is similar in construction to chuck 104, the apertures 130 thereof being adapted to engage corresponding pins 131 in the face of flange 132 forming part of the spindle 133. The latter is supported for rotation in bearings 134 set into a housing 135 also forming an integral part of the frame 61. Spindle 133 is threadedly received to a nut 136 for endwise retention of the same, while flange 132 functions correspondingly at the opposite end. An end cap 137 attached by screws 138 locks left-hand bearing 134 to housing 133. Intermediate to the lock 103 and flange 132 is an oil deflector disc 141 to deflect oil or grease thrown from right-hand bearings 134 away from the grinding zone.

Cap 137 includes an oil seal 142.

Shaft 133 is reduced in diameter at 143 and is again reduced to provide a pilot 144. A chuck 145 is adapted to fit over portion 143, the chuck carrying set-screws 146 bearing against steps 147 cut into portion 143 whereby a predetermined accurate angular positioning between the chuck and shaft 133 may be set and maintained. Inserted in the left-hand face of chuck 145 is a pair of pins 148 adapted to mate with apertures 151 in the template 92, a central aperture 152 thereof fitting over pilot 144.

For maintaining template 92 against the chuck 145 there is a disc 153 having a resilient ring 154 cemented thereon and in contact with the template. Serves to support disc 153 is a chuck 155 including pins 156 entering apertures in the disc.

In order to permit rapid disengagement of a template 92 and engagement of another template, and to provide the pressure necessary to hold the template in operative position, there is an arm 161 slidable in an aperture 162 in housing 163, the arm being axially apertured at 164 to slide upon a fixed stud 164. Stud 164 is secured in the frame 61 by a pin 165, and the head 165 of the stud 164 abuts a compression spring 167 positioned within a recess 168 thus normally to urge arm 161 inwardly. A pin 172 projecting
In two directions from stud 154 engages diametrically opposed slots 173 in the wall of the arm 151, whereby arm 151 is maintained in the angular position shown during the grinding operation, but is free for rotation to clear the template 92 for removal when arm 161 is manually drawn to the left.

The upward extension 175 of arm 161 supports a pivot 178 including two oppositely extending cylindrical portions 177 and 178, the former being pressed tightly into a suitable aperture 179 in extension 175, and the latter fitting freely in an aperture 180 in chuck 155.

For rotating the blank 91 and template 92, the power shaft 42 is utilized, the same being slotted at 181 to receive alldy a pin 182 secured through a pinion 183. The pinion 183 is constantly biased to the left by compression spring 184 intermediate pulley 34 and pinion 183, while the pinion is maintained in proper relation with the head 69 by means of bracket 168 secured to the head 61 and the arm 62. Pinion 183 meshes with an idler pinion 186 revolving on stud 184, and pinion 185 in turn drives a pinion 187 keyed at 186 to spindle 133.

In order that the head 69 and the parts carried thereby may oscillate toward and away from the face of the grinding wheel and against the tension of the spring 78, an adjustable follower mechanism is provided. In this connection it will be understood that a particular template may be used for a great many different sizes of lenses, i.e., having varying transverse dimensions. Accordingly, it becomes necessary, by appropriate setting of the template follower, to initially fix the position of the lens blank with respect to the face of the wheel. Such result could also be obtained by moving the wheel, but such adjustment is not resorted to until the limit of co-operative adjustment between template and follower has been reached and it can no longer accommodate for wearing of the wheel.

The follower mechanism is best shown in Fig. 5 and includes an integral anvil 191, provided with an arbor 192, there being a circular aperture 193 and an arccuate slot 194 therein. A bracket 195 includes a forwardly extending bifurcated portion 196 in the space of which the arm 152 is slidably fitted. Cup screws 197 extend through portion 196 and the apertures 193 and 194, and by means of which anvil 191 may be rotated through the arc permitted by slot 194 in order to present the face of the anvil most advantageously to the template 92. Bracket 195 includes a dovetail recess 201 adapted to engage slidably a corresponding formed plate 202 fastened by screws 203 to the top wall 15. A downwardly extending arm 198 passes through clearance holes 204 and 205 in the wall 15 and plate 202 respectively, and is secured to bracket 195 by screws 206.

Arm 198 has a threaded aperture 207 with which a threaded stud 208 is engaged, the forward end of the stud passing through wall 13 and being secured in a handle 209. A stop collar 212 retains stud 208 against the wall 13 and permits rotational movement only thereof. Consequently, to effect forward and backward adjustment of the anvil 191, handle 209 is rotated to shift arm 198 and bracket 195 in the desired direction.

The machine of the instant invention may utilize a cylindrical grinding wheel on the edge of which the work bears, or I may use the sloping face of a frusto-conical wheel. The latter is shown in the drawings (Fig. 2) and comprises a "rough" grinding surface A and a "finish" grinding surface B, the wheel 210 being supported on the usual spindle 211 supported rotatably in suitable bearings. The latter are supported in a quill 200 carried by a bracket 213 extending from the base block 214. If desired, the block may be adjustable angularly with respect to the frame of the machine in order that the faces A and B may be aligned accurately with the axis of the work, and may be adjustable transversely to accommodate for wear of the wheel. An electric motor 215 drives a belt 216 which passes over a pulley 217 keyed to the spindle 211.

In order to protect the worker from the spray and splash of the wet grinding operation, the frame 61 is provided with side wings 221 and 222 intermediate which is the arcuate transparent hinged guard 223 (Fig. 4) having a handle 224 for raising and lowering the same. Guard 223 is preferably of a transparent plastic material. A fixed rear guard 225 also supported on the frame 61 co-operates with guard 223 and has a slotted aperture 226 to clear the spindle 211.

To furnish water to the grinding area, a nozzle 231 is provided, the fluid being pumped from a suitable reservoir in the base 63 of the machine through conduit 232 and the flow thereof is controllable through valve 233. The pump may be driven by motor 27.

Assuming the lens 91 shown has been ground, and that template 92 has served its purpose, the handle 124 is grasped to swing the head 60 about the shaft 42 against the tension of the spring 78. Meanwhile the left hand holds the finished lens 91, so that without removing his right hand from handle 124, the same may be rocked clockwise to cause pinion 122 to operate the spindle 127 to the right. Thus pad 94 is released from the lens and it may be removed to the usual holding tray. Now with the left hand free, the operator may grasp the arm 161 by hooking his fingers around extension 175 to withdraw the arm to the left against pressure of the spring 167, whereupon the arm may be rotated to clear the template 92, the freed arm then resting with its inner end face against pin 172. Accordingly the left hand is now free to remove the template from pins 148 and to insert the template required for the next lens to be ground. Arm 161 is then released from locked position and restored to the position shown in Fig. 1 to grip the template. Following this the next blank lens is inserted between the pads 93 and 94, handle 124 is released to clump the blank, and the head 60 is restored to normal, i.e., grinding position.

In the event the template 92 just inserted is of the correct contour but not of the transverse dimensions required by the new blank 91, it is necessary to adjust the position of the blank relatively to the face of the grinding wheel by movement of anvil 191. Rotation of handle 209 will effect such adjustment in the manner already described. Such adjustment is generally predetermined by the operator, and is preferably made before the blank 91 is brought against the wheel 210. In Fig. 1 the head 91 is shown in position for rough grinding, i.e., to the right. To locate the blank 91 in proper position for finish grinding, i.e., to face B, the handle 72 is turned to move stud 67 in its threaded aperture and to force the head 60 to the left, the spring 184 urging the same and moreover maintaining proper yielding engagement of the follower 53 with cam 46. Shifting of the blank from rough-
to finish-grinding is effected without stopping the machine or making any adjustments other than rotating the handle 72.

Inasmuch as stud 67, flange 65 thereof, and the threaded engagement of the stud with arm 63 of the head 55 renders the sleeve 51 unitary with the head, rotation of cam 48 will oscillate the head laterally of the machine to reciprocate the blank across the face A or face B as required for uniform wear of the wheel faces and cleanliness of the finished edge of the lens.

To facilitate loading of the blank between the pads 53 and 54, any of the well-known work-holders may be used. In one such holder the optical center of the lens is located in a true axial position with respect to and between the discs 59 and 66, and the latter with the lens clamped therebetween are transferred to the chucks 132 and 134. In that way the optical center of the lens lies on the axis of the spindles 131 and 133. Rapid and accurate positioning of the template 92 with respect to the said axis is effected by registration thereof with the pilot 144 and pins 146, the latter preserving angular positioning of the template with respect to the lens blank, and the pilot 144 taking the pressure against the template due to spring 78.

The machine of my invention is flexible to a degree not found in prior equipment, especially in so far as the template gripping arrangement is concerned. As heretofore pointed out, either a standard flat metal template as shown in Fig. 1, may be used or, in those cases where no such template of the proper contour is available and it is desired to match a broken lens, the alternative construction shown in Fig. 6 is employed.

By comparing that figure with Fig. 1, it is to be noted that a ring 236 adapted to fit over pilot 144 and having a resilient pad 237, together with the disc 153 heretofore described, is utilized, the disc 236 having a pair of apertures engaging pins 146. Accordingly the mate 138 to the broken lens is preliminarily set up with disc 153 and ring 236 in a work-holder as described, and the assembly transferred intermediate the chucks 145 and 155.

In contrast to lens edge grinders now available utilizing cylindrical grinding wheels of conventional material, e. g., wheelstone, silicon carbide, or aluminum, I provide 35 a grinding wheel comprising diamond particles and silicon carbide or any so-called "diamond" grinding wheel. It has been found that the speed of grinding increases approximately threefold, the wheel is effective for longer periods between re-dressings, and a much lighter motor may be used due to the smaller size of the diamond wheels.

One of the outstanding advantages of my machine resides in the simple means for transferring the work from the rough-to-the-finish-grinding surface of the wheel. Prior devices required rather bothersome manipulation of set-screws with respect to the oscillating cam, the adjustment being made twice for each blank ground. However, my machine is almost instantaneously and positively settable by handle 72, the movement of arm 63 being limited intermediate cam 53 and the arm 59.

Another means for holding the metal template 92 is shown in Fig. 8, in which form the swinging arm 161 is not utilized, and the end of the spindle 143 is provided with an integral axial pilot 240 of phosphor bronze or other resilient material diometrically slotted as shown, whereby the same may be sprung slightly to grip the standard central opening in the template, and a pair of pins 241 is also provided to engage the standard locating holes of the template. While the means of Fig. 8 affords a more rapid change from one template to another, the preferred embodiment employing the arm 161 is more positive.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A grinding machine of the class described comprising a frame, a power shaft rotatably mounted in said frame, a head angularly oscillatable and reciprocably slidable on said shaft, a spindle rotatably mounted on said head and having an axis parallel to said power shaft, a second spindle coaxial with said first spindle and rotatable therewith, a chuck at one end of said first spindle, a chuck at the adjacent end of said second spindle, said chucks including resilient means for gripping the work therebetween, said second spindle being freely rotatable in said head, said first spindle being driven by said power shaft, there being transmission means between said first spindle and power shafts, a chuck at the opposite end of said first spindle for holding a template, an arm slidably mounted with respect to said head, said arm including a chuck adapted to engage one face of said template, and resilient means associated with said arm for applying engaging pressure to said template, said arm and head having mutually engageable means for maintaining a predetermined position of the chuck therewith respect to said template, said means being disengageable manually for removing said template from the machine.

2. In a grinding machine of the class described having an oscillatable and swingable work-carrying head a cam rotatable therewith, a sleeve axially slidable on said shaft, a cam follower carried by said sleeve, a pair of spaced-apart flanges integral with said sleeve, an arm integral with said sleeve and extending radially therefrom, a bracket carried by the head and having opposed faces and an aperture engageable over said sleeve, and manual means interconnecting said arm and bracket for shifting said head relatively to said sleeve for varying the lateral position of the work.

3. In a grinding machine of the class described having an oscillatable work-carrying head for traversing the work across the face of the grinding wheel, a power-driven rotatable shaft, carrying a cam, a member axially slidable relatively to said shaft, said member including a cam follower portion, and screw-threaded means adjustable securing said member to said head for shifting said member relatively to said head whereby to alter the range of movement of the work relatively to the face of the wheel.

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