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METHOD AND APPARATUS FOR GRINDING AND POLISHING OPTICAL PRISMS

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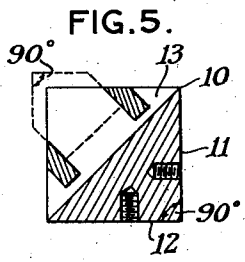
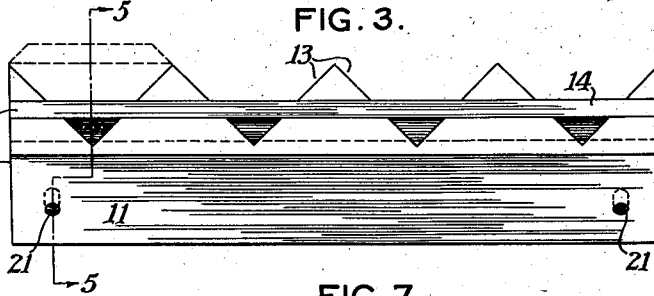
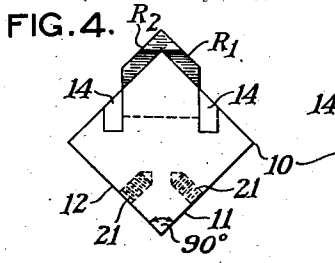
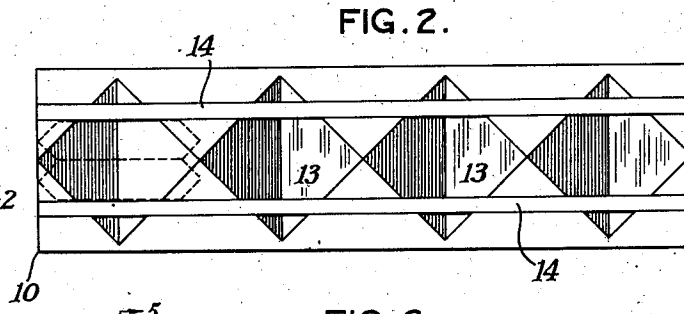
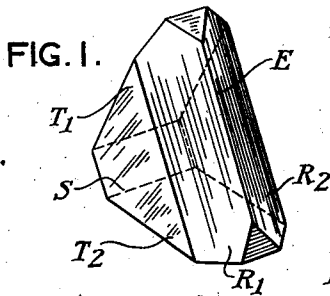


FIG. 7.

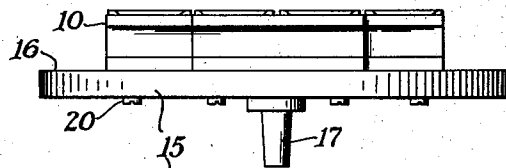


FIG. 6.

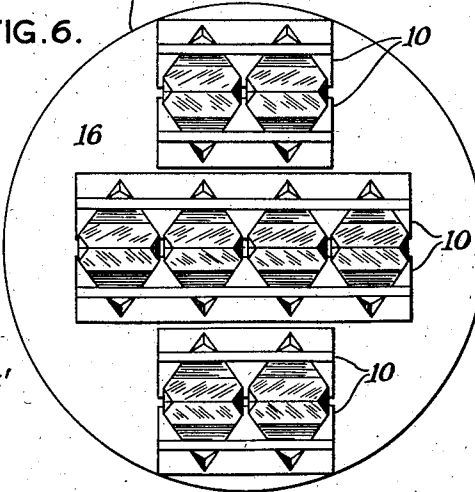
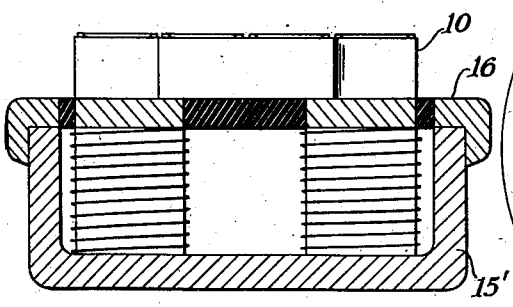


FIG. 8.



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METHOD AND APPARATUS FOR GRINDING
AND POLISHING OPTICAL PRISMS

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1 Claim. (Cl. 51-216)

The present invention relates to a method of and apparatus for grinding and polishing surfaces of a prism, and particularly a method and apparatus for grinding and polishing two angularly related surfaces of a prism to obtain a desired angle therebetween without the necessity of re-blocking the prism.

The grinding and polishing of the roof surfaces of roof-angle prisms require extreme accuracy in order to secure a roof angle within a few seconds' tolerance of the angle required. The roof surfaces must also be oriented accurately with regard to the transmission surfaces of the prism. It is common practice to secure this required accuracy by a series of hand corrections in grinding and polishing the prism surfaces. The surfaces are usually first ground, and then the prisms are mounted in plaster of Paris blocks for machine polishing. After the polishing operation the inaccuracies in the prism detected optically are corrected by hand operations. This operation of hand correction is a difficult one since an angle must be corrected without spoiling the flatness of the polished surfaces. For this reason it is very essential that errors in the prism as the result of machine polishing be kept very small so that the corrected prism shall have good optical definition. It is difficult with conventional apparatus and methods to machine polish prisms accurately enough to overcome the necessity of rather extensive hand correction. Because of this fact, it is not uncommon to encounter errors which are so great that they cannot be adequately corrected by hand operation to meet more rigid tolerances, and even if they are small enough to be capable of hand correction the production of prisms is curtailed due to the necessity of such extensive hand correction.

One object of the present invention is to provide an apparatus for blocking prisms by the use of which the surfaces of a roof angle can be ground and polished by machine to secure a very accurate angle, and by the use of which the hand correction of angle error is eliminated, or reduced to a minimum, and the production of prisms is thereby substantially increased.

Another object is to provide a blocking device for prisms by means of which a prism needs to be blocked but once for the grinding and polishing of two surfaces forming the angle in question.

And still another object is to provide a blocking device which has two locating surfaces precisely ground to form an angle corresponding to that to be generated on a prism, the alternate engagement of the locating surfaces of the block with a

plano-surface of a table serving to orient the prism blocked therein so that the surfaces to be ground are respectively properly located relative to the grinding plane to generate the angle in question.

And a further object is to provide a blocking device of the type set forth which can be accurately held on the plano surface of the table by mechanical or electrical means.

And yet another object is to provide a method of grinding and polishing the roof surfaces of a prism which eliminates damage to the edge of the roof angle, by chipping or otherwise, by making use of the blocking device set forth.

The novel features that we consider characteristic of our invention are set forth with particularity in the appended claim. The invention itself, however, both as to its organization and its methods of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawing in which:

Fig. 1 is a perspective view of an Amici roof prism, the roof surfaces of which are adapted to be ground and polished with the method and apparatus of the present invention in order to accurately control the roof angle,

Fig. 2 is a top plan view of a blocking device constructed in accordance with a preferred form of the present invention for blocking a plurality of Amici roof prisms for grinding and polishing the roof surfaces thereof. A roof prism is indicated in a block positioned therein,

Fig. 3 is a side view of the blocking device in the position thereof shown in Fig. 2,

Fig. 4 is an end view of the blocking device shown in Fig. 3,

Fig. 5 is a section of the blocking device taken substantially on line 5-5 of Fig. 3, and with the device turned so that one locating surface thereof is horizontal,

Fig. 6 is a top plan view showing a plurality of blocking devices with prisms blocked therein mounted on a polishing table in adjacent relationship to insure the formation of a sharp roof edge,

Fig. 7 is a side view of the assembly shown in Fig. 6, and

Fig. 8 is a vertical section showing another embodiment of the polishing table wherein the table constitutes a magnetic chuck.

Like reference characters refer to corresponding parts throughout the drawing.

Briefly, according to the present invention the

blocking device for a prism the roof surfaces of which are to be finished comprises a block having two locating sides which are adapted to alternately locate the block in two different positions of orientation on a plano surface of a grinding and polishing table. A prism is adapted to be supported by the blocking device so that the two surfaces to be finished extend beyond the confines of the block and are respectively located relative to the two locating sides of the block so that each roof surface will in turn be properly positioned relative to the grinding plane when the block is alternately located on the plano surface of the table by said locating sides. Accordingly, the angle between the locating sides of the block control the generation of the roof angle of the prism, and the locating sides should, therefore, be precisely made to give the angle desired in the prism. Furthermore, a sharp roof edge can be assured if one roof surface of each of two prisms is finished first, and then the two prisms are mounted with their finished surfaces in surface contact and their second surfaces in substantially the same plane, and finally the second surface of the prisms are simultaneously finished while the prisms are so mounted.

In order to clearly point out the present invention, the specific problem of grinding and polishing the roof surface of an Amici roof prism will be considered. However, it is pointed out that the finishing of such a prism is only a representative case and, as will be clear from the following description, the invention is not limited to the production of such a prism, but is capable of application in the production of many different types of prisms. An Amici roof prism is of the form shown in Fig. 1 and includes two transmission surfaces T_1 and T_2 and two roof surfaces R_1 and R_2 which intersect at a roof edge E . In certain uses of this prism it is imperative that the roof angle formed by the roof surfaces be accurately 90 degrees, and that the roof edge be sharp throughout its length and free of chips or other damage. Accordingly, the present invention will be disclosed in the form of a specific embodiment used to grind and polish the roof surfaces of an Amici prism of the type shown, without reblocking and without intermediate hand correction, to an accuracy such that no, or at best only very small, final hand correction of the polished surfaces is necessary.

Referring now to the drawing, and particularly Figs. 2-5, the apparatus comprises a prism supporting block 10 which is rectangular in shape and is of such a length as to support a plurality of prisms in endwise relation. Two adjoining sides 11 and 12 of the block are ground and lapped to be plano and form a precise right angle, and the precision of these sides is critical because they serve to determine the orientation of the prism relative to the grinding plane. It is pointed out that while we have chosen to show the locating sides 11 and 12 of the block as single continuous surfaces, it may be desirable to mill away portions of the surfaces leaving only two or more raised areas which are ground and lapped accurately to define the locating plane desired. For example, these locating surfaces may constitute two substantially narrow rails running the length of the block at the corners, or they may comprise a plurality of regular or irregularly shaped raised areas ground and lapped to define a plane. Limited locating areas may possess certain advantages over a continuous locating area. For instance, it is easier to grind and lap limited

spaced areas to a given plane than it is a substantially large continuous surface. In addition, the presence of dirt on the table is not so apt to effect the orientation of the block if limited locating areas are used instead of one substantially large locating area. These two sides of the block will be referred to hereinafter as the locating sides of the block because of their function, and this term is intended to cover the case where the sides 11 and 12 are each one continuous surface as shown, or comprise two or more limited locating areas as set forth.

In the corner of the block opposite the two locating sides are milled a plurality of 90-degree V grooves 13 into each of which a prism is adapted to be seated in the manner shown, with each of the transmission surfaces engaging one wall of the groove. The prisms may be held against sideways movement in the groove 13 by a pair of side rails 14 slipped into slots milled lengthwise of the block and separated by a distance such that the inside face of each side rail engages one side wall S of the prism, see Fig. 3. The combination of the V grooves 13 and the side rails 14, therefore, provides a plurality of seats into each of which a prism will be seated with one roof surface substantially parallel to one of the locating sides of the block and with the other roof surface in the same relation with respect to the other locating side of the block.

The individual prisms may be secured in their respective seats in any one of a number of ways. One suitable way would be to insert strips of wax paper between the prism and the block and then to heat the block and apply pressure to the prism to obtain a good bond between them. It will be observed that when the prisms are mounted in the block as described, the roof surfaces to be ground and polished extend beyond the confines of the block so as to be accessible to the grinding and polishing tools, not shown. While we have set forth a particular manner of forming the prism seats in the block which lends itself to ready fabrication of the block, it will be appreciated that these prism seats could be formed in any convenient manner without going beyond the scope of the present invention.

After the prisms are mounted in the supporting block in the manner set forth, the block is placed on a grinding table 15 with one of the locating sides 11 or 12 of the block in surface contact with the surface 16 of the table which is accurately plano. As is well known, this table may be provided with a spindle 17 extending vertically from the bottom thereof and which spindle is adapted to connect the table with a rotating or oscillating mechanism, not shown. The drive for the table is of no importance so far as the present invention is concerned but the fact that the table must be mounted so that its plano top surface 16 is constantly parallel with the grinding plane is important. The roof surfaces of a prism extending beyond the confines of the block and parallel to the plano surface of the table are ground and polished by tools, not shown, adapted to be brought down into engagement therewith from above the table.

When the prism supporting block is placed on the table with the locating side 11 thereof in contact with the plano surface of the table, the prisms are properly oriented relative to the grinding plane so that the roof surface of the prism opposite that locating side will be ground and polished to a plane accurately parallel with that locating side. After one roof surface of each of

the prisms is finished, the block 10 is turned over on the table to bring the other locating side into surface contact with the plano surface of the table and the second roof surface of each of the prisms is ground and polished without having to reblock the prisms (without having to remove the prisms from the seats in the blocking tool, turning them around, and reseating them in the blocking tool) as is the common practice now. It will thus be seen that the locating sides of the blocking tool determine the respective planes of the finished roof surfaces of the prism, and that if the angle between the locating sides is an accurate right angle (or any other angle) the angle between the roof surfaces will be equal thereto.

The blocking tool may be detachably secured to the plano surface of the table 15 by a plurality of bolts 20 adapted to extend through bores in the table and into tapped openings 21 in the respective locating sides of the blocking tool. The tapped openings 21 in the blocking tool should be sufficient in number and suitably spaced to permit the blocking tool to be drawn into accurate surface contact with the table without danger of deforming the tool. The preferred manner of holding the blocking tool on the surface of the table is to make the table a magnetic chuck, as well known and as indicated in Fig. 8, so that the tools will be held on the table by magnetic force. Such an arrangement would insure the blocking tool being accurately held on the table because the pull on the tool at any point would be substantially the same. Furthermore, the magnetic chuck arrangement would tend to speed up production because the disconnection and connection of the blocking tools to the table surface would merely require connecting the coil of the chuck to, and disconnecting it from, a source of potential by means of a switch.

It is important that the roof edge E be kept sharp and free from chips. This is accomplished according to the present invention by grinding and polishing the first roof surface of a pair of prisms; then supporting the prisms in pairs with the finished roof surfaces of each in surface contact and with the second roof surfaces assuming substantially the same plane, which is parallel to the grinding and polishing plane; and finally grinding the two second roof surfaces simultaneously while the two prisms are so supported. This is accomplished in the present instance by grinding and polishing the first roof surface of a plurality of prisms blocked in two or more blocking tools, then mounting pairs of blocking tools in adjacent relationship on the plano surface of the table 15 in the manner shown in Figs. 6 and 7. When the blocking tools are mounted in pairs as shown in these figures, the previously finished roof surfaces of the prisms in the respective blocking tools are brought into surface contact and the second roof surfaces of the prisms lie in a substantially common plane, and are all simultaneously ground and polished parallel to the plano surface of the table. To prevent scratching of

the finished roof surfaces which are brought into surface contact, it may be desirable to place a thin film of shellac or other material between them. With this particular arrangement of parts, the precisely finished locating sides of the blocking tool control the roof angle, and at the same time sharp roof edges, free of chips, are obtained because the edge of either one of the roofs is supported at all times during grinding and polishing of the second roof surface by the finished roof surface of the associated prism. The blocking tool should be made of a material having dimensional stability, and we have found that nickel-molybdenum cast-iron properly heat treated to give dimensional stability, is very satisfactory for this purpose.

It is believed that it will be obvious from the above description that the present method and apparatus makes possible the production of very accurate prisms in a much shorter time than heretofore possible. The blocking tool permits the two roof surfaces of a roof angle to be ground and polished by machine without requiring a reblocking of the prism in the tool. The locating sides of the tool control the orientation of the prism for the proper working of the two roof surfaces so that the roof angle is accurately controlled by the angle between the locating sides of the tool which can be precisely made without difficulty in machining the blocking tool. The roof angle can be so accurately controlled by this blocking tool that no, or very little, hand correction of the prism angle is required. Furthermore, the idea of simultaneously grinding and polishing the second roof surfaces of two prisms while the two previously finished roof surfaces thereof are in surface contact assures the production of the sharp roof edges free from chips, a criterion which has been difficult to obtain by prior art procedures without using such care that the production was appreciably slowed down.

Although we have shown and described certain specific embodiments of our invention, we are fully aware that many modifications thereof are possible. Our invention, therefore, is not to be limited to the precise details of construction shown and described but is intended to cover all modifications coming within the scope of the appended claim.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

The method of grinding and polishing the second face of a roof angle on an optical prism so that the roof edge of said angle will be sharp and free from chips and comprising the steps of grinding and polishing the first face of the roof angle of two similar prisms, then mounting said two prisms on a support relative to a grinding plane with the finished first face of each in surface contact with one another and with the second face of each lying in substantially a common plane, and simultaneously grinding and polishing the second face of each of said prisms.

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