METHOD AND APPARATUS FOR MAKING COMPLEX ASPHERIC OPTICAL SURFACES

BACKGROUND OF THE INVENTION

Various methods have been used for making complex aspheric optical surfaces, particularly for Schmidt corrector plates used in Schmidt-Cassegrain telescopes and Schmidt cameras. Various techniques have been proposed involving the drawing of the glass blank into contact with a die surface to facilitate reproduction to high accuracy. Illustrative of two of such methods are U.S. Pat. No. 3,837,124 granted Sept. 24, 1974 to Thomas J. Johnson and John F. O'Rourke, and U.S. Pat. No. 3,837,125 granted Sept. 24, 1974 to Thomas J. Johnson, both patents directed to a vacuum deformation technique using a configured die surface.

In Johnson U.S. Pat. No. 3,837,124, a two piece Schmidt corrector plate die assembly comprises a glass block and a thin glass die plate optically contacted therewith and having the inverse of the desired curve. This die plate is produced by first grinding and polishing a glass blank to the desired figure, locating its optical center, optically contacting this plate to a solid block with the central axis of the plate coinciding with the rotational axis of the block, and vacuum deforming a third glass piece onto this combination. This third glass piece is then ground and polished to become the inverse die plate in the master die.

Johnson U.S. Pat. No. 3,837,125 uses a thick one piece master die which itself is ground and polished to a curve inverse to that of the desired curve, rendering testing of the curve somewhat involved as test corrector plates must be produced therefrom for testing as the surface is being figured. The configuration of these test plates must be optically analyzed and the apparent corrections to the figure of the master die estimated. Then these corrections must be figured into the master die. If any changes are desired in the production plates which would necessitate refiguring the master die, this indirect testing procedure must be repeated.

Accordingly, it is an object of this present invention to provide a novel and relatively facile method for producing complex aspheric optical surfaces efficiently and accurately.

It is also an object to provide such a method wherein a one piece master die is used to make inversely curved die plates and is relatively rugged and is figured to the curve to be produced, thus facilitating direct optical testing.

Another object is to provide an apparatus for use in such a method.

SUMMARY OF THE INVENTION

It has now been found that the foregoing and related objects of the invention are readily attained in a method for making complex aspheric optical surfaces wherein a glass block is initially formed with a pair of substantially parallel flat surfaces. One parallel surface of the block is ground and polished to the desired aspheric configuration to form a master die block and then there is brought into contact with the aspheric surface of the master die block an optically flat surface of a deformable glass blank. A vacuum is drawn through the master die block to deform the glass blank into optical contact with the aspheric surface, and the opposite surface of the glass blank is ground and polished to substantially an optical flat to provide a die plate. Upon releasing the vacuum and removing the die plate from the master die block, the opposite surface of the die plate assumes a configuration substantially inverse to that of the aspheric surface of the master die block. Thereafter the optically flat surface of the die plate is brought into optical contact with an optically flat surface of a base die block to form a die block assembly with the aspherically configured surface of the die plate being exposed and providing a configuration substantially inverse to that of the aspheric surface of the master die block.

Once a die block assembly has been formed a finished optical surface is made therefrom by bringing into contact with the aspherically configured surface of the die block assembly an optically flat surface of a deformable glass plate and drawing a vacuum through the die plate to deform the glass plate into optical contact with the aspherically configured surface. The opposite surface of the glass plate is ground and polished to substantially an optical flat, the vacuum is released and the glass plate is removed from the die block assembly. The opposite surface of the glass plate then assumes a configuration substantially conforming to that of the aspheric surface of the master die block.

In its preferred aspect the method of the present invention includes the additional step of forming at least one passage through the master die block extending from the aspheric surface to another surface thereof and drawing the vacuum therethrough. Grooves are formed in the optically flat surface of the glass blank and communicate with the passage through the master die block to facilitate drawing the vacuum between the glass blank and master die block. In customary practice, the opposite surface of the glass blank is normally ground and polished to an optical flat.

Also in its preferred aspect, the method includes the additional step of forming at least one passage through the base die block and die plate, the passage through the base die block and die plate communicating upon formation of the die block assembly and extending from the aspherically configured surface to another surface thereof. Grooves are formed in the aspherically configured surface of the die plate and communicate with the passage therethrough to facilitate drawing the vacuum between the die plate and the glass plate to be figured thereon. The opposite surface of the glass plate is normally ground and polished to an optical flat.

Thus the present invention utilizes a unique assembly for making inverse curve die plates for the production of complex aspheric optical surfaces comprising a master die block and a deformable glass blank wherein the master die block has one surface with the desired aspheric configuration and at least one passage extending therethrough from the aspheric surface to another surface thereof and may be tested to ensure that it has the desired figure. The glass blank has an optically flat surface with grooves therein disposed adjacent and drawn into optical contact with the aspheric surface of the master die block to conform thereto, and its grooves communicate with the passage in the master die block for drawing of the vacuum therebetween. In accordance with usual practice, the exposed surface of the glass blank opposite the optically flat surface is ground optically flat while in this assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a glass block used in the present invention prior to grinding and polishing;