N. A. SHIGON.

REFRACTOMETER.

APPLICATION FILED JULY 1, 1915.

1,270,336.

Patented June 25, 1918.

3 SHEETS—SHEET 1.

Fig. 1.

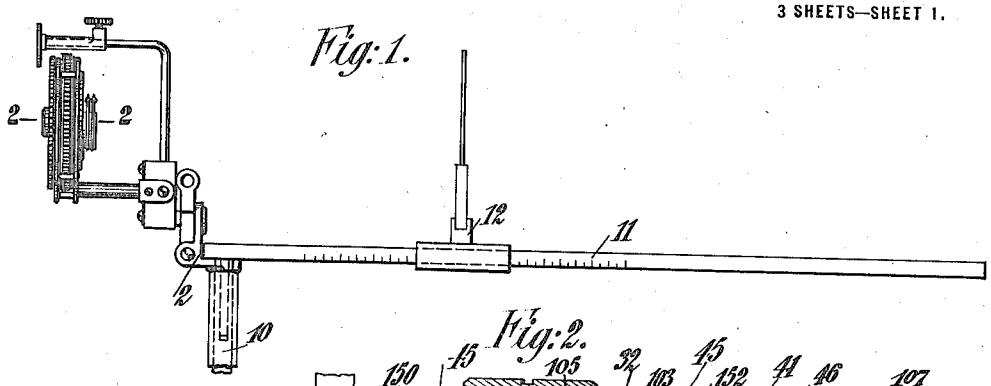


Fig. 2.

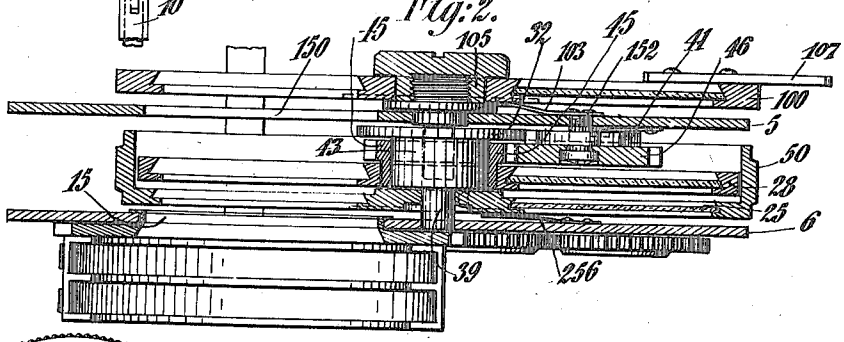


Fig. 3.

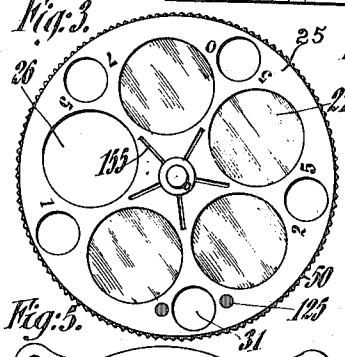


Fig. 4.

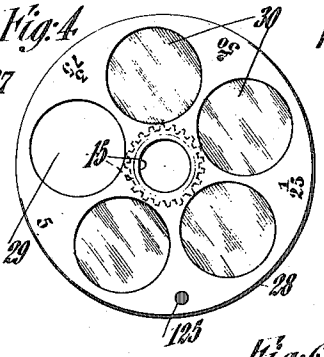


Fig. 7.

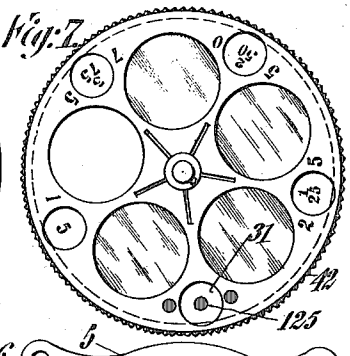


Fig. 5.

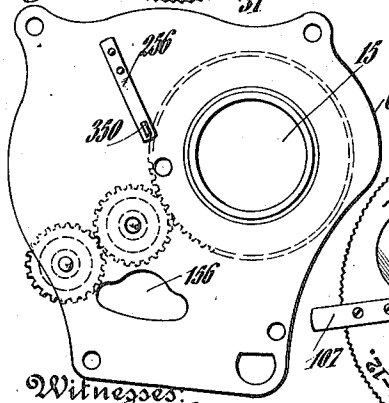


Fig. 8.

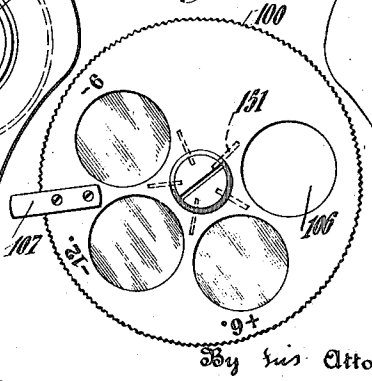
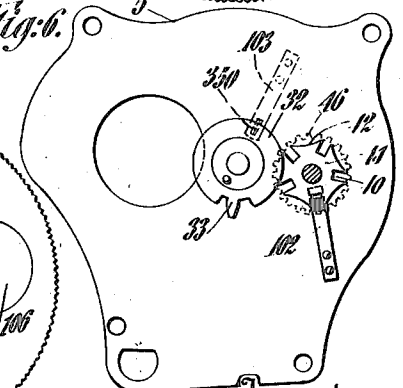


Fig. 6.



Witnesses:

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By his Attorney Carl P. Goebel

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3 SHEETS—SHEET 2.

Fig: 9.

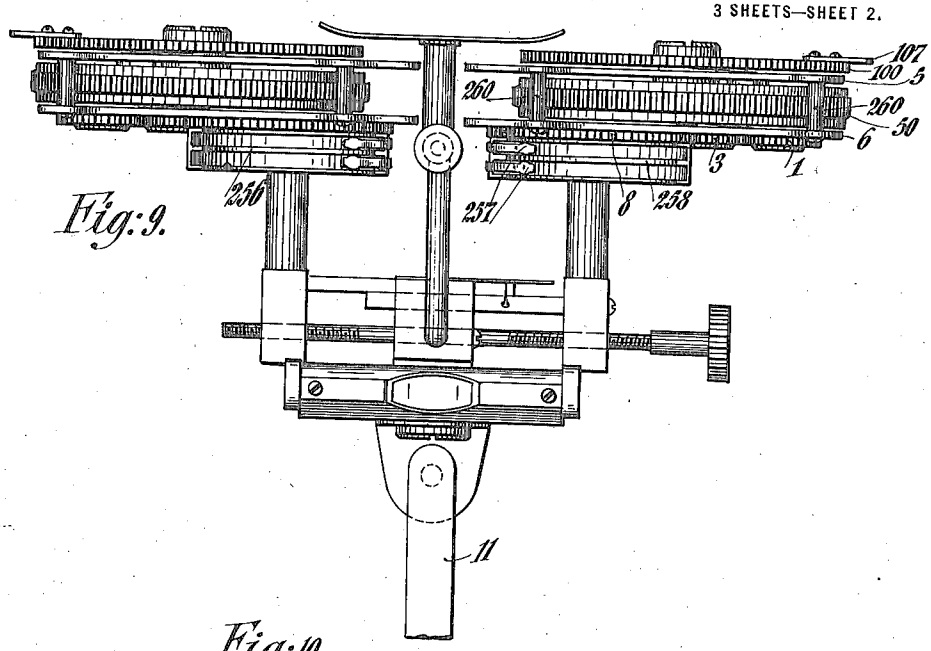
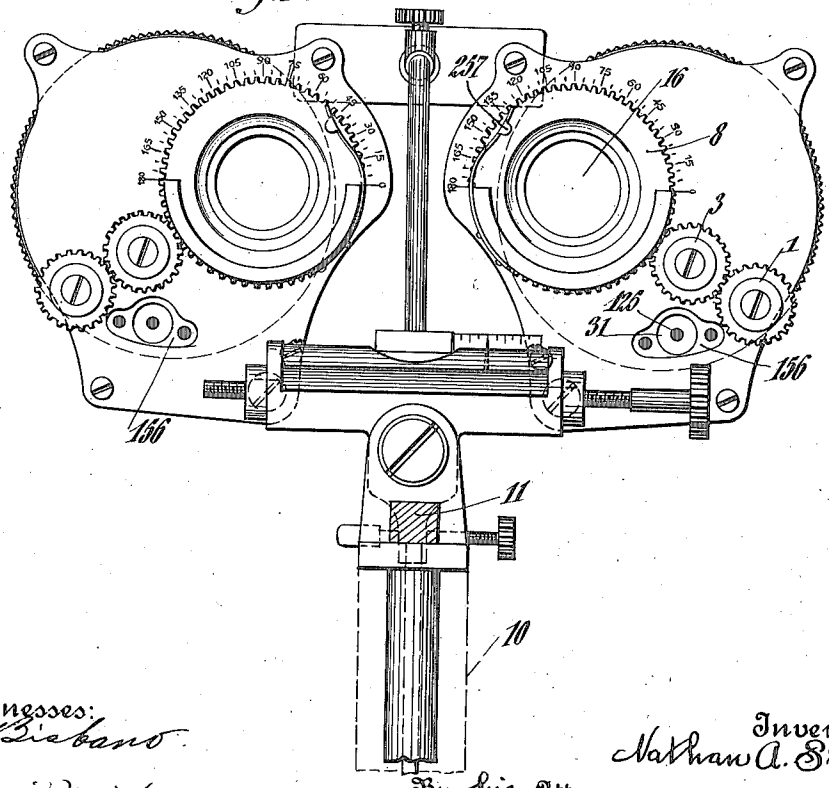


Fig: 10.



Witnesses:

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3 SHEETS—SHEET 3.

Fig:11.

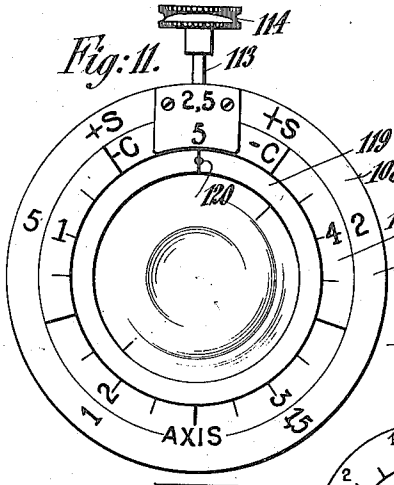


Fig:12.

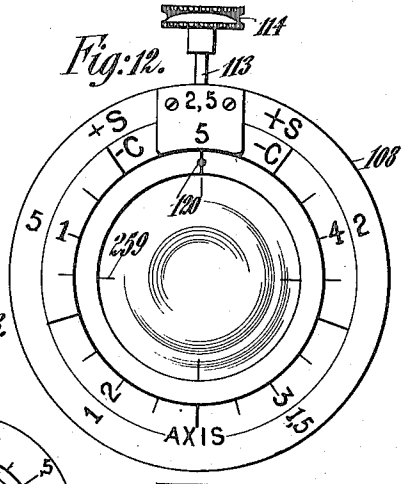


Fig:13.

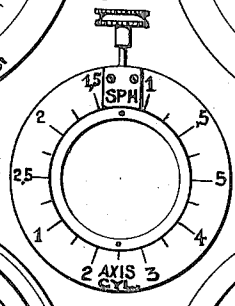


Fig:14.

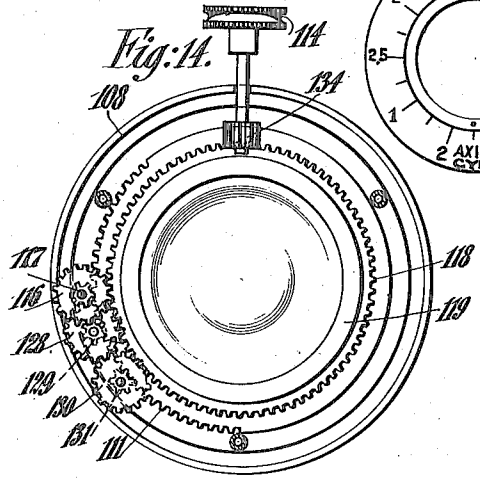


Fig:15.

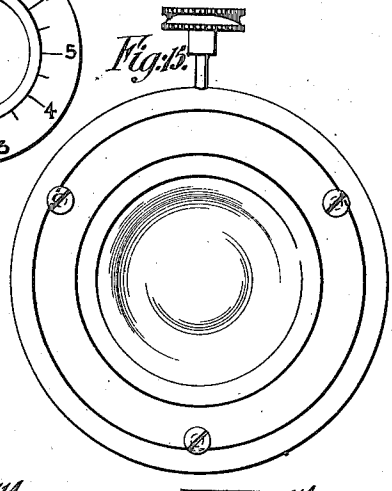


Fig:16.

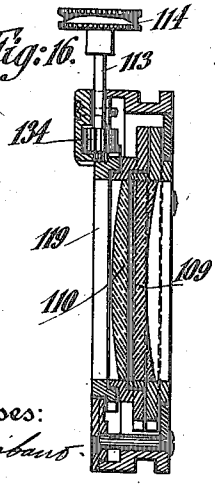


Fig:17.

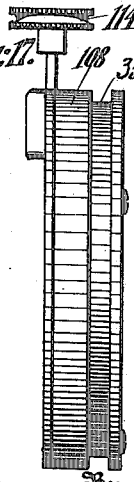
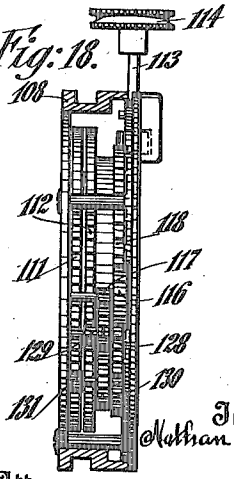


Fig:18.



Witnesses:

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F. Kenn Morton.

Inventor

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By his Attorney

Carl P. Gabel

UNITED STATES PATENT OFFICE.

NATHAN A. SHIGON, OF NEW YORK, N. Y.

REFRACTOMETER.

1,270,336. Specification of Letters Patent. Patented June 25, 1918.

Application filed July 1, 1915. Serial No. 37,447.

To all whom it may concern:

Be it known that I, NATHAN A. SHIGON, a citizen of the United States, and a resident of the borough of the Bronx, county of the Bronx, city and State of New York, have invented certain new and useful Improvements in Refractometers, being improvements upon the patent granted to me on December 27th, 1910, as United States Patent No. 979,578. The following is a full and clear specification of the aforesaid improvements.

My improvements are directed toward making the instrument more simple, convenient, compact, and readily constructed, and in providing a more reliable positioning of the plus and minus lenses employed for determining the amount of myopia or hypermetropia of the patient, and also means for more quickly and reliably determining the amount of astigmatism of the patient, and consists further in certain arrangements and combinations of parts more particularly pointed out hereinafter and shown in the annexed drawings, in which,

Figure 1 is a perspective view of my refractometer showing the same applied to a refraction rule;

Fig. 2 is a section of the refractometer taken on line 2—2 through the shaft of the disk, so as to show the relation of the parts;

Fig. 3 is a detail front view of part of the front spherical lens-carrying disk;

Fig. 4 is a detail view of the inner spherical lens-carrying disk;

Fig. 5 is an inner view of the front plate;

Fig. 6 is an inner view of the back plate, showing the spring pawl coöperating with the star-wheel, and a supplementary pawl for the supplementary disk;

Fig. 7 is another detail view showing the reels of spherical lenses superposed upon each other;

Fig. 8 is a view of the disk carrying the supplementary lenses;

Fig. 9 is a top view of the complete mechanism;

Fig. 10 is a front view of the mechanism;

Fig. 11 is a front view of the lens system for determining the astigmatism of the eye, with the axes of the cylindrical lenses parallel;

Fig. 12 is another front view with the lenses in a different relation, with the axes at right angles;

Fig. 13 shows the structure of Figs. 11 and 12 with different indexing;

Fig. 14 is a detail front view of the gears for reversely and simultaneously revolving the index circlet and the lenses for testing the astigmatism, having the top removed;

Fig. 15 is a rear view of Figs. 10 and 11;

Fig. 16 is a central vertical cross-section through Fig. 11;

Fig. 17 is a side view of Fig. 11; and

Fig. 18 is a detail side view of the mechanism shown in Fig. 14.

Similar letters of reference indicate corresponding parts.

Referring to the drawings, a support 10 is detachably connected at 2 with a graduated bar or refraction rule 11 adapted to have movable thereon a support or sliding holder 12 for holding a small card or chart of test type, or other testing appliances, which support is adjustably fixed by any suitable means.

Rearwardly of the opening 15 of the front plate, different test lenses are successively arranged before the eye, one set being first used. This first set is superimposed upon a second set, and the second set is moved in relation to this first set, all as is well known and set forth in my former patent. The lenses are readily arranged in disks, one disk 25 with an opening 26 and having plus lenses 27 being revolved with respect to a second disk 28 having an opening 29 and plus lenses 30, each disk having each lens numbered so as to correspond with its strength. The disk 25 is provided with openings 31 to enable the numbers of the lenses of the inner disk 28 to be read. This disk 25 is provided with a circumferential flange 50 having a milled surface for adapting it to be readily grasped by the user, which circumferential flange embraces the disk 28, but permits its free rotation in respect to it herein. These two disks and their housing and two plates 5 and 6 form a battery of lenses to be used in connection with a supplementary disk 100, as shown in Fig. 8.

As described in my former patent, plates 5 and 6, which are fastened by posts 260, are provided with an arbor 39 having a circular plate 32 with a projection 33, which at each complete revolution, or four

quarters of a diopter, engages a notch 40 of a star-wheel 41, having between the notches 40 curved portions 42 to prevent the star-wheel from further rotation. The arbor is further provided with an enlarged portion 43 having loosely fitting thereon the disk 28 having a gear-wheel 45 secured thereto, which gear-wheel 45 engages a gear-wheel 46 secured to the star-wheel 41, which gear-wheel and star-wheel are rotatable on the smooth end of a partially threaded screw 152 screwed in a screw-threaded opening in the plate 5. The portion 43 forms with the arbor 39 a shoulder, on which the first disk 25 rests. The disk 25 is secured against rotation relative to the arbor by means of a pin or lug rigidly secured to the arbor and engaging the disk 25.

By the rotation of the disk 25 by means of the milled surface on the flange 50, successively the opening 26 and each lens 27 are brought in alinement with the opening 29 of disk 28 and openings 15 and 150 of the plates 5 and 6. If the proper strength of lens is found before the complete revolution of the disk 25, the number is noted through supplemental opening 156 of the front plate. If the correct lens in the first disk is not found, the rotation of the first disk is continued until the second disk receives by means of the projection 33 engaging the star-wheel 41 and the meshing of the gears 45 and 46. a movement equal to the distance between two lenses. By the continued rotation of the first disk 25, the opening 26 of the first disk 25 is brought in alinement with the openings 15 and 150, at the same time as the first lens 30 of the second disk is brought in alinement with the openings 15 and 150. The first disk is then intermittently rotated until the completion of its rotation, whereupon the second disk is again shifted a short distance so as to bring the second lens 30 of the second disk in line with the opening 26 of the first disk and with the openings 15 and 150. This is continued and the different combinations of lenses made until the proper lens is found.

Thereupon a notation is made of the different lenses, through the supplemental opening 156, by means of the numbers on the disks corresponding to the strength of the lenses, as shown in Fig. 7, the points 125 representing zero lenses or openings. The shifting of the second disk relatively to the openings 15 and 150 in plates 5 and 6 takes place entirely automatically by the manipulation of the first disk and in such a manner that the user of the apparatus does not perceive it, whereby his attention is not in the least affected, and thereby tests are in no manner affected by such disturbance. The combined value of the two disks is seen through supplementary opening 156.

Experience has shown that the movement of the projection 33 engaging with the notches 40 of the star-wheel 41 is not always regular, so that the lenses are not placed accurately into central position. I have, therefore, provided a spring pawl 102, as shown in Fig. 6, which yieldingly engages the notches 40, so that the star-wheel is always maintained in a definite position, and the lenses are maintained in an accurate central position. The supplementary disk 100, later described, as shown in Fig. 8, has a number of radial notches 151, five in this embodiment, which coöperate with a projection 350 on the spring pawl 103, so that this supplementary disk 100 is maintained in central position. The disk 25 has five similar notches 155 coöperating with spring pawl 256.

In order to provide for different refractive errors of the eye, I provide a supplementary disk 100, which is placed behind the casing of the other two disks heretofore mentioned, which disk 100 is provided with three lenses, and one opening 106, one opaque part, and the lenses are plus 6, minus 6, and minus 12 diopters respectively, or any other lenses suitable for this purpose may be used. The disk 100 is mounted on the shaft 105, and is provided with a projecting index 107, which projects beyond the frame at the side when the opening 106 is in line with 15 and 150. A lens of suitable strength can, therefore, be placed before the eye of the patient, or the empty space can be thus placed, or if desired, the opaque portion of the disk 100 between the openings therein can be interposed before the eye of the patient, so that one of the eyes of the patient is covered while the other is tested. The lenses thus far described and their accompanying apparatus have been for the purpose of testing the refractive errors of the eye, for hypermetropia or myopia.

For testing the amount of astigmatism of the eye, I provide a revolubly mounted disk 8 with a toothed periphery, which meshes with gears 1 and 3, so that when the toothed wheel 1 is revolved, this disk 8 will also be revolved. To this disk 8 is attached a lens frame or holder, in which can be inserted cylindrical or prismatic lenses, stenopaic slits, or any form of auxiliary optical apparatus, which must be revolved before the eye of the patient, as lenses for determining astigmatism, muscular imbalance, and the like.

Thus, a casing 108 may be held and revolved by means of gears 1 and 3. The use of two gears is advantageous in that small gears may be thus utilized, so that the opening 156 in plate 6 for the inspection of the lens number and the graduation of the scale is not obscured. If one gear were used, this would have to be too large, so as to project out of the frame. A scale of 180° co-

operates with the disk 8, so as to determine its position, and the disk 8 has a central opening 16 coincident with openings 15 and 150 in the plates 5 and 6. The casing 108 in this embodiment has two cylindrical lenses of the same refractive value, but with opposite signs. These two lenses 109 and 110 in this embodiment are respectively minus 2.50 and plus 2.50, or other strengths can be used.

Of course, two sphero-cylinders of opposite sign may be used, or instead two cross-cylinders. Two cylinders with the same sign can also be used to produce a sphero-cylinder. The lenses 109, 110 are set in ring-frames provided with toothed peripheries 111 and 112. A spindle 113 is provided with a thumb piece 114 by means of which it may be revolved. The spindle 113 is provided with the spur-gear 134, which meshes with the spur-gear 118, forming the periphery of a circlet 119 provided with an index mark 120, so that when the spindle 113 is revolved, the circlet 119 with its index-mark revolves with it. The spur-gear 118 meshes with the toothed wheel 116, which has a smaller spur-gear 117 on the same shaft therewith. The spur-gear 117 meshes with the spur-gear 128. The spur-gear 128 has on the same shaft therewith the smaller spur-gear 129, which meshes with the toothed periphery 112.

The spur-gear 128 also meshes with the spur-gear 130, which has the small gear 131 on the same shaft therewith, the spur-gear 131 meshing with the toothed periphery 111. Therefore, when the spindle 113 is revolved, the circlet 119 with the index mark and one of the lenses revolves in one direction, while the other lens is revolved in the opposite direction. The gears are so proportioned that when the circlet 119 with its index mark 120 is revolved to 360°, the two lenses are each revolved—of course in opposite directions—45°, or one-eighth of a circumference. The gears can also be so proportioned that when the circlet 119 with the index 120 revolves half a circumference the two lenses would also revolve one-eighth of a circumference, or any other desired proportion. In Fig. 13, one index points to the sphere, and one index points to the cylinder.

It is well known that when the two cylindrical lenses, one plus and one minus, are placed with their axes parallel, as in Fig. 11, and shown by mark 120, that one lens will neutralize the effect of the other, so that the light passing through both lenses will be affected just as though it had passed through a sheet of plane glass with parallel faces. If the two lenses are placed with their axes at right angles to each other, as in Fig. 12, and indicated by 120, one meridian will produce plus 2.50 cylinder, while the other meridian at right angles will produce minus 2.50 cylinder, or at any intermediate position of the cylinders, a fraction of a diopter in one meridian will be plus and the other meridian at right angles will be minus, which will be equal to a sphero-cylinder after transposition. The zero effect of the two superposed cylindrical lenses is determined by looking through them, and seeing that there is no refraction. This shows that their axes are superposed. The marks 259 are parallel to the cylindrical axes of the lenses.

When the axes of the superposed cylindrical lenses are themselves superposed, so that there is no refraction, these superposed axes are at 45°, or one-eighth of a circumference from the vertical, either at the right or left side of the vertical, as in Fig. 11. The advantage of this arrangement is that as the lenses are revolved in opposite directions, there is no change of angularity in the lines viewed through the cylindrical lenses, so that the tests can be made much more accurate. The diameter of the scale on either dial having the word "Axis" marked at the end thereof is at 45° to the superposed axes of the cylinders, Fig. 11, when these cylinders are in zero position. As the cylindrical lenses are revolved, their axes diverge, the maximum divergence being 45° from the position of zero effect, and their maximum relative divergence being 90°, as in Fig. 12.

The ring-frames holding the cylindrical lenses are toothed only for 45°, or one-eighth of a circumference, as shown in Fig. 14, so that it is impossible to have a greater relative divergence than 90°. At the termination of these 45° toothed arcs, there are no stops of any kind, but the toothing is not continued, so that further revolution is impossible, but the gears remain meshed, so that they can be revolved in the reverse direction, back to the position of zero effect.

To avoid mistakes in transposition, I provide two dials 132 and 133, which coöperate with the circlet 119 having the index 120, so that the optical values of the lens system may be known immediately, in their transposed form and value. One of the dials 132 is marked plus S, so as to indicate the plus sphere, and the other dial 133 is marked minus C, so as to indicate the value of the minus cylinder. As the circlet 119 revolves, therefore, the index 120 indicates the optical values in the transposed sphero-cylindrical system. The graduations of the scales need not be set too closely together, since the circlet 119 with the mark 120 revolves more rapidly than the cylindrical lenses. The casing 108 is for testing the astigmatism of the eye. It is inserted into the lens cell or lens holder attached to the revolving plate 8, and kept in position with a spring 257, in order that other testing lenses may be inserted into the same lens holder. I separate this lens holder with a partition 258, so that it

forms a double lens holder. The casing 108 has a groove 359 around its rim, (Fig. 17) to permit of its insertion into this lens holder and its free rotation around its center.

In this manner, the cylindrical axis and the means for recording the optical values produced by the reversely rotating cylindrical lenses and means for transforming the optical values into sphero-cylindrical equivalents, are provided, and the entire instrument operates as a unit to completely test the eyes of the patient in a minimum of time and with a maximum of convenience.

I have illustrated preferred and satisfactory forms of my invention, but it is obvious that changes may be made therein, within the spirit and scope thereof, as defined in the appended claims.

I claim:—

1. In combination, a frame provided with a sight opening, two disks carrying spherical lenses mounted on a common axis within said frame, means for manually revolving one of said disks, means coöperatively connecting said disk to the other disk, and adapted to successively bring the lenses of said other disk in line with said sight opening as the first mentioned disk is turned through one revolution, and an independently revoluble supplementary disk mounted on said common axis, said supplementary disk carrying supplementary plus and minus spherical lenses, and adapted to be brought into line with said sight opening, and provided with a free opening, and an opaque portion adapted to be brought into line with said sight opening.

2. In combination, a frame provided with a sight opening, two disks carrying spherical lenses mounted on a common axis within said frame, means for revolving said disks with respect to each other so as to bring different lenses on said disks together automatically, and a revoluble supplementary disk mounted on said common axis, said supplementary disk carrying supplementary plus and minus spherical lenses and being provided with a free opening, said supplementary disk having an index thereon adapted to project beyond the periphery of said frame when said free opening is in line with said sight opening of said frame, and out of line of sight or vision when said lenses are in line with said sight opening.

3. In combination, two disks carrying spherical lenses mounted on a common axis, means for revolving said disks with respect to each other so as to bring different lenses on said disks together automatically, and a revoluble supplementary disk mounted on said common axis, said supplementary disk carrying supplementary plus and minus spherical lenses, said supplementary disk being made of opaque material, and having a part thereof intermediate the respective lenses thereof of sufficient size to cover the lenses of said two disks in the line of vision of the patient's eye.

4. In combination, a frame, comprising a pair of spaced plates provided with alined openings, two disks mounted on a common axis between said plates, and respectively provided with lenses adapted to be brought successively in line with said openings, means mounted on one of said plates adapted to coöperatively connect one of said disks to the other, and adapted to successively bring the lenses of said other disk in line with said openings as said first mentioned disk is turned through one revolution, means for manually turning said first disk, an independently revoluble supplemental disk mounted on said common axis exteriorly of said frame, and adapted to be readily removed without disassembling said frame, said supplemental disk carrying lenses to be used in combination with the lenses of said other disks.

5. In combination, two plates, an arbor on said plates, two disks carrying spherical lenses and revolubly mounted on a common arbor, a star-wheel constantly connected to one of said disks and plates, and revolving with the disk connected thereto, means on the other of said disks for intermittently engaging said star-wheel to move the first of said disks a predetermined distance, and a spring pawl for yieldingly engaging the notches of said star-wheel, and exactly centering the lenses of said first disk.

6. In a refractometer having a pair of reversely disposed frames, one for each eye, arranged side by side, frame plates for each of said frames having a central arbor, and alined openings therein disposed between said arbor and the inner edges of said plates, revoluble disks carrying spherical lenses, and mounted on said arbor between said plates, said lenses adapted to be successively revolved before said openings when said disks are revolving, markings on said disks to indicate the lenses in registration with the said openings, a supplemental opening in one of said plates to view said markings, a scale on said plate, a perforated revoluble disk having a toothed periphery, mounted on said plate, and having its perforation in registration with said openings on said plates, and a plurality of relatively small gears for turning said perforated revoluble disk meshing with said toothed periphery thereof, said gears clearing said supplemental opening, and said scale of said plate, and projecting in proximity to the outer edge of said plate for manual manipulation, and means on said revoluble disk for holding lenses or other testing appliances therein.

7. In a refractometer having a pair of reversely disposed frames, one for each eye,

arranged side by side, frame plates for each of said frames having a central arbor, and alined openings therein disposed between said arbor and the inner edges of said plates, revoluble disks carrying spherical lenses, and mounted on said arbor between said plates, said lenses adapted to be successively revolved before said openings when said disks are revolving, markings on said disks to indicate the lenses in registration with the said openings, a supplemental opening in one of said plates to view said markings, a scale on said plate, a perforated revoluble disk having a toothed periphery, mounted on said plate, and having its perforation in registration with said openings on said plates, and means for turning said perforated revoluble disk meshing with said toothed periphery thereof, said means clearing said supplemental opening, and said scale of said plate, and projecting in proximity to the outer edge of said plate for manual manipulation, and means on said revoluble disk for holding lenses or other testing appliances therein.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

NATHAN A. SHIGON.

Witnesses:

JOS. BISBANO,

D. LEWIS MATTEN.