A CONVENIENT PRISM SCALE.

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A CONVENIENT PRISM SCALE.*

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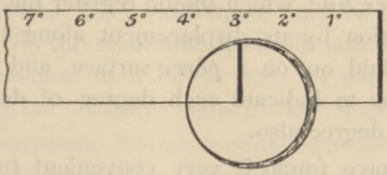
THE need for a more accurate and rapid method of testing and neutralizing prismatic lenses, either singly or in combination with spheres and cylinders, has been strongly emphasized by the increasing interest and attention devoted to the study of heterophoria, and the broader clinical application of prisms for its relief.

To [1]Maddox is probably due the credit of first suggesting a "Prism Scale" for this purpose. In his little work on prisms, published in July, 1889, he states that in the year 1886 he arranged



(Fig. 1.)

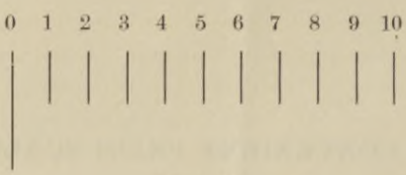
for Messrs. Pickard and Curry, of London, a scale for measuring the deviating angles of prisms. (Fig. 1) This was numbered in tangents of degrees arranged on a horizontal plane, and adjusted to show the amount of deviation at a distance of two meters. The scale was also provided with an index line and a base line, both very important, but was without any linear gradations to designate the degrees.

In October, 1891, [2]Prentice, in one of his learned papers on the optical principles of prisms, suggested his "Prismometric Scale," (Fig. 2) which he based on the prism-dioptry as a unit. This scale,

*Read before the Ophthalmological Section of the American Medical Association at its meeting in Milwaukee, June 6th, 7th, 8th and 9th, 1893.

[1]Maddox on "Clinical Use of Prisms," Page 29.

[2]American Journal of Ophthalmology, Oct., 1891.



(FIG. 2.)

like that of Maddox, was arranged on a horizontal plane, with a prominent index line, but lacking the very important base line. It was further provided with gradations so adjusted as to show the deflection at the longer range of six meters.

In order to make a prism scale meet all the indications which its use demands, there are certain requirements which we may consider absolutely essential. In the first place, such a scale should have a prominent *base line* by which the prismatic lens may be kept in perfect alignment while testing. The slightest rotation of the base-apex line (axis) of such a prism above or below the horizontal base line of the scale not only impairs its value in that plane, but also causes a corresponding deviation in the vertical plane. If such a deviation should occur by mistake in a prescription glass, it would, of course, inflict on the patient an artificial hyperphoria. Another essential is the *index line*, which should register the exact number of degrees of deviation by its displacement along the scale. This scale should be laid out on a *plane* surface, and be marked with *linear gradations* to indicate each degree of deviation; and, if desired, the half degree also.

In practice I have found it very convenient to have *two* such scales, one arranged on a *horizontal* plane, and the other on a *vertical* plane. This enables the observer to quickly measure a pair of prismatic spectacles, while holding them in the same horizontal position in which the patient naturally wears them. In this way the exact degree is easily ascertained no matter in what direction the base of the prism is placed. To still further facilitate their practical application these two scales should be made in contrasting colors, e. g., the *horizontal* scale in *black*, and the *vertical* one in *red*. A combination scale of this character would prove of additional utility in the case of *resultant prisms*, which have for their effect the double action of two super-imposed prisms, placed exactly at right angles to each other, the axis of the one being vertical, and that of the other horizontal. By the use of such a scale we would secure, therefore, the twofold advantage of being able to read off both these values at once.

[1] Maddox, in 1889, laid down the mathematical formulæ whereby the values of such resultant prisms might be estimated; and [2] Wallace, in 1892, published an elaborate table of the degree and the angle of rotation for any required resultant prism. This latter table, however, possesses the single disadvantage of being expressed in minute fractions of a degree, which renders it almost impracticable, as it is extremely difficult for the optician to grind such a lens. It will probably be advisable, therefore, to avoid these fractions of a degree, and obtain the resultant prism expressed in whole numbers. This can be best accomplished by employing a very simple method based on the use of the prism scale, and easily applied by any oculist, even though not an expert mathematician, as we will attempt to demonstrate later on in this paper.

The prism-unit, which has elicited so much discussion as to the relative merits of "prism-dioptry" and "centrad," has by a graceful compromise been definitely established through the following resolution, presented by Drs. Jackson, Burnett and Randall:

[3] Resolved, "That the section on Ophthalmology of the American Medical Association, adopt and recommend as a standard or unit prism one which gives a *deflection of one centimeter at the distance of one meter*, and that this measurement may be taken on a *plane* up to No. 20." By this resolution the child was born, but without a name; in the absence of a better one, we will continue to call this prism-unit by the ancestral name of the "degree."

For practical purposes, it is more convenient to adjust the prism scale for use at a distance of two meters, which will require a corresponding amplification of the prism-unit, i. e., "a deflection of *two* centimeters at *two* meters." This will allow greater latitude of movement for the observer, with only half of the error at the shorter distance. The two-meter distance is, furthermore, better adapted for use in the offices of those oculists who do not possess the advantage of a full six-meter range; and as well for the many opticians who are compelled to do their grinding in limited quarters.

In order to properly meet all these indications I devised in January, 1889, a simple prism scale, which has proved of such great convenience in my own practice that I now desire to submit it to

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[1] "Clinical Use of Prisms," Pages 98 and 112.

[2] Annals of Ophthalmology and Otology, Vol. I., No. 2.

[3] Trans. Ophthal. Section American Medical Association, 1891, Page 7.

the profession for a more extended trial. By constant use it has been modified and improved until it has finally assumed its present shape. To briefly summarize, it possesses the following qualifications:

1. The scale is arranged on a plane surface of cardboard or heavy paper.

2. The prism-unit is adjusted for "a deviation of two centimeters at a distance of two meters."

3. It possesses both a horizontal scale in black, and a vertical scale in red.

4. The index line of one scale is the base line of the other scale, and *vice versa*.

5. The index or base lines are heavier than the degree gradations, and terminate in arrow-head indicators.

6. The scale is graduated for degrees and half degrees, the horizontal scale extending to 20° and the vertical one to 10°.

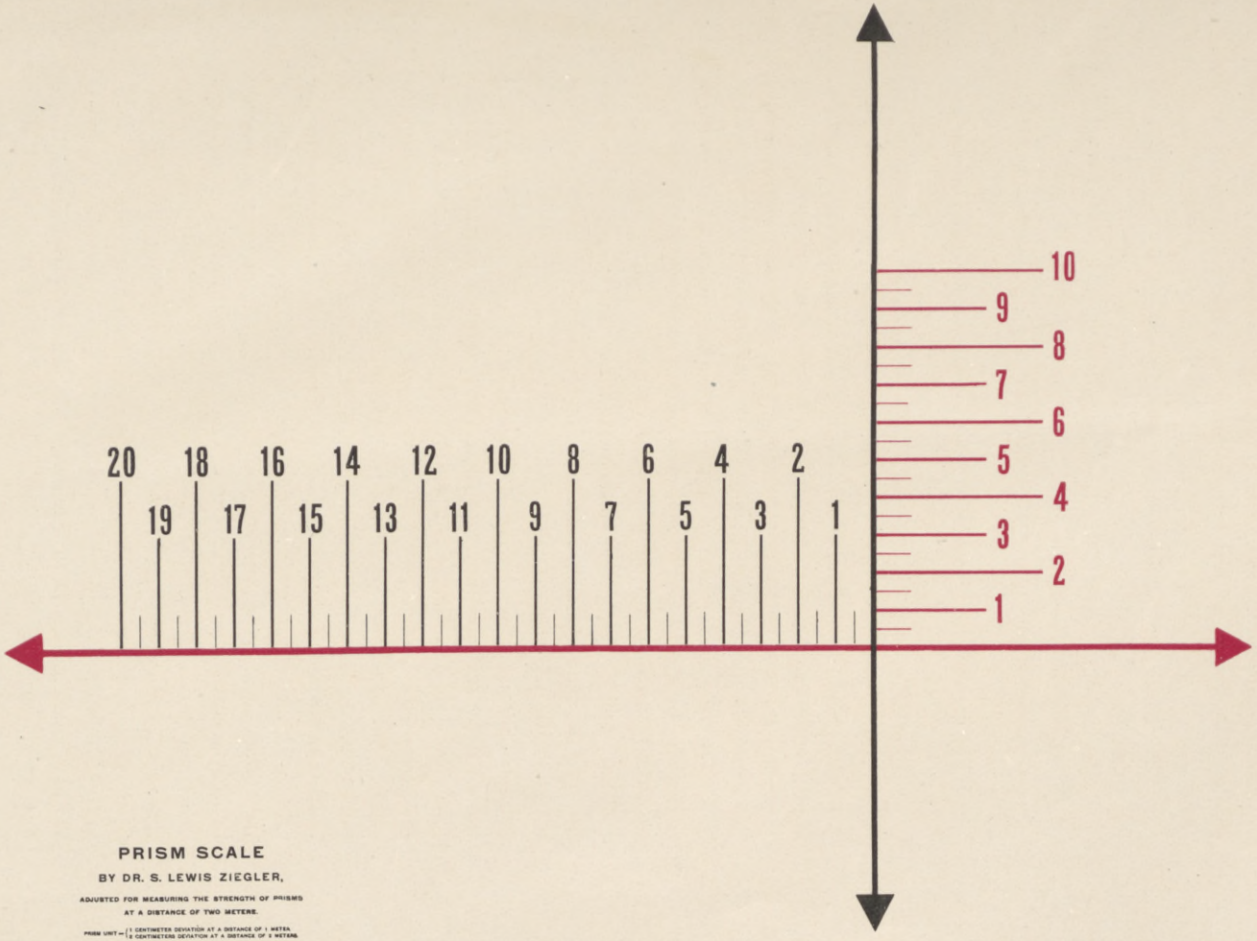
7. For the sake of quick readings the even and odd numbers are arranged on different levels.

8. The two scales are so joined that the angle of a resultant prism can be easily ascertained before prescribing, or the strength as quickly measured after it has been ground.

This "Prism Scale," as described above, has been published for me by Messrs. J. L. Borsch & Co., of Philadelphia, who have had it handsomely lithographed.

METHOD OF USE:—The Prism Scale should be framed[1] and hung on the wall of the room in a good light, with the horizontal base line (red) adjusted absolutely level, and about four to five feet from the floor. The observer will then stand facing the scale, and directly opposite the junction of the vertical and horizontal base lines. Hold the prism to be tested about nine inches in front of the eye, and at exactly two meters from the scale. The distance from the eye is immaterial so long as the prism remains on the two-meter line. A convenient method is to mark the two-meter range on the floor, and by experiment ascertain how far behind this the observer should stand. This distance will usually average about six inches. We can then draw a heavy line on the floor which should always be toed, and will make the range exactly at two meters when the prism is held nine inches from the eye. If we should prefer to work sitting down, the scale should be placed lower on the wall,

[1] A glass cover will prevent soiling from dust and dirt.



PRISM SCALE

BY DR. S. LEWIS ZIEGLER,

ADJUSTED FOR MEASURING THE STRENGTH OF PRISMS AT A DISTANCE OF TWO METERS.

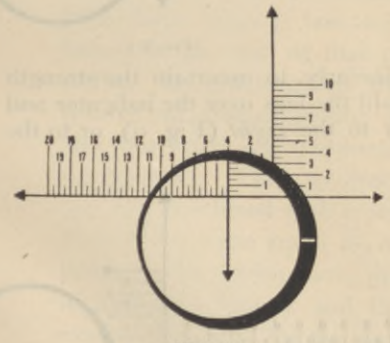
PRISM UNIT — { 1 CENTIMETER DEVIATION AT A DISTANCE OF 1 METER. 2 CENTIMETERS DEVIATION AT A DISTANCE OF 2 METERS.

PUBLISHED BY A.L. BOSCH & CO., PHILADELPHIA

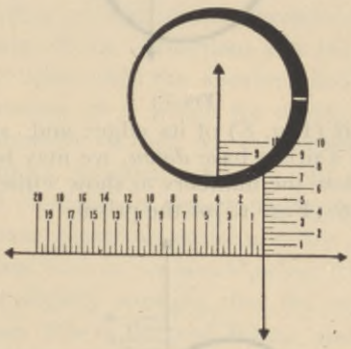
but still on a level with the observer's eyes. The most accurate method is to arrange for a permanent two-meter mark, by adjusting an upright standard on the floor, or by constructing a wooden arm to let down from the wall at the proper range, on either of which we may rest the lens while testing its strength.

We must now close one eye, and with the other one practice looking at the scale both *through* the prism and *over* it, as it is on the comparison of these two views that we get the required registration. Each of these dual fields should contain either the *indicator* singly or the *numbered gradations* singly, the prism being so held that the two fields shall be in conjunction at the margin of the lens. We next level up the prism by rotating it until the base line seen through the prism coincides and is continuous with the base line of the scale, and therefore indicates the axis of the prism. To avoid another possible source of error the plane of the prism should always be kept parallel with that of the scale, as any tilting tends to vitiate our result.

The index line will now be displaced along the scale until the indicator stands opposite the proper numbered gradation, thereby showing the strength of the prism. By rapidly moving the prism up and down along the gradation it can easily be seen whether the index line accurately coincides with the proper gradation, and thus shows the required strength. This reading may be taken in either one of two ways for each position of the prism. If, for example, we select a prism of 4° and place it with the base to the *right* (Fig. 3),



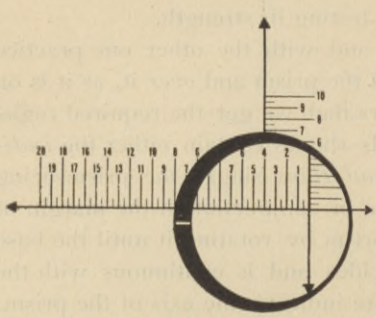
(Fig. 3.)



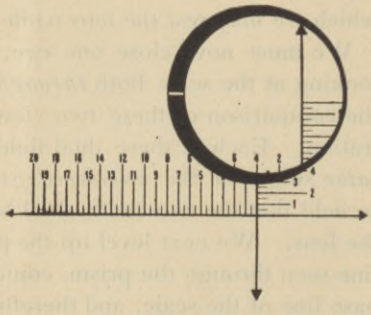
(Fig. 4.)

we will see the indicator through the prism standing directly *under* the No. 4, as seen just above the margin of the lens. The same result may be secured on the upper register (Fig. 4) by viewing the displaced indicator through the prism as it stands directly *above* the

4° gradation on the scale. If, however, we reverse the prism and place the base to the *left* we will find the indicator standing *above* the figure 4 as seen through the prism (Fig. 5), or in like manner *under* the 4° gradation (Fig. 6).

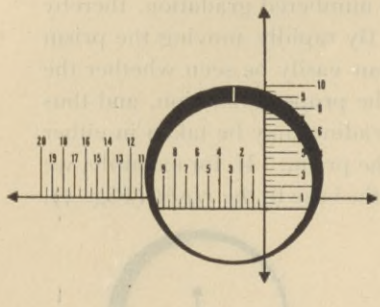


(FIG. 5.)

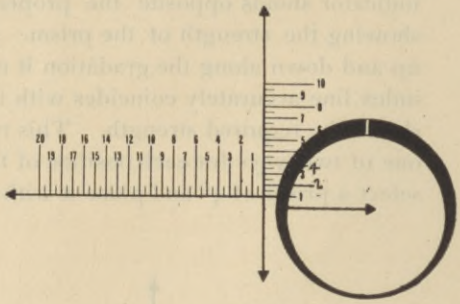


(FIG. 6.)

To measure a prism base *up*, we line up the axis to the vertical base line, the numbered gradations showing through the prism, and the indicator appearing just to the *right* (Fig. 7), or to the

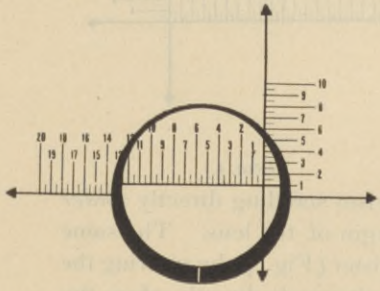


(FIG. 7.)

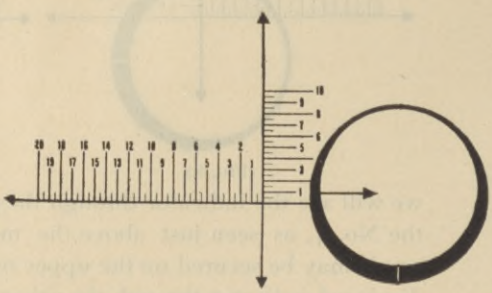


(FIG. 8.)

left (Fig. 8) of its edge; and, similarly, to ascertain the strength of a prism base *down*, we may hold the lens over the indicator and allow the numbers to show either to the *right* (Fig. 9), or to the *left* (Fig. 10)of the prism.



(FIG. 9.)



(FIG. 10.)

In some of the aforementioned positions it is possible to level up the prism on the base line while reading off the result, while in others we cannot do this when holding the prism in position. It is, however, an easy matter to do this before selecting the most convenient register. A little practice will soon furnish the greatest facility in the use of all these positions, whether on the base lines, or on the alternatives.

Resultant prisms are not very generally prescribed as such. The oculist usually prefers to order separately the individual vertical and horizontal prisms, thereby delegating to the optician the solution of the problem. The optician invariably performs his task by *neutralizing* the combination, and in this way resolves it into the equivalent resultant prism. As previously stated, we desire to avoid, if possible, such minute subdivisions of a degree as are impracticable for the optician to grind, and which the *exact* mathematical reduction must invariably give. We have, however, an easy and satisfactory solution of this problem based on a simple *clinical fact*, and accomplished by the use of our prism scale.

This clinical fact may be stated as follows: In hyperphoria it is necessary to order the *full* correction; while in exophoria or esophoria we may order anything from a *partial* correction to a *full* one, according to circumstances. I take it, therefore, that as the relief of a hyperphoric deviation requires a more *exact* correction than that of exophoria or esophoria, so the *vertical* prism should *exactly* correspond to whatever correction we decide to order; while for the *horizontal* deviation we may allow a *greater latitude* without impairing the efficiency of our correction, and may order the strength from $\frac{1}{2}^{\circ}$ less to $\frac{1}{4}^{\circ}$ more than the absolute amount obtained by the test, or that portion of it which we desire to prescribe. By granting this statement as true, we can immediately resolve our crossed prisms into a resultant prism of full degree, and thus avoid any fractional elements to disturb the manufacturing optician. Thus, to illustrate, should we desire to order a prism base up, combined with a prism base in, we would select from our trial case a prism equal to, or slightly stronger than the strongest prism in our combination, place this in the trial frame, and rotate its base-apex line up and in until the desired vertical strength is exactly registered on the vertical scale; then by looking along the horizontal scale it will be found that the reading corresponds so nearly to the desired prism that the error is inappreciable.

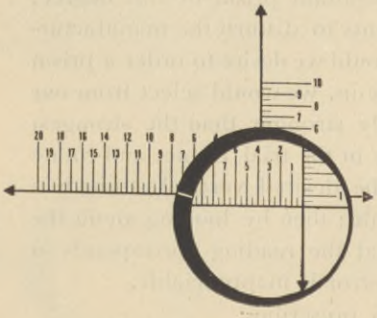
If, for example, we should wish to prescribe

℞ O. D. P 4° base in, ⌒ P 1° base up,

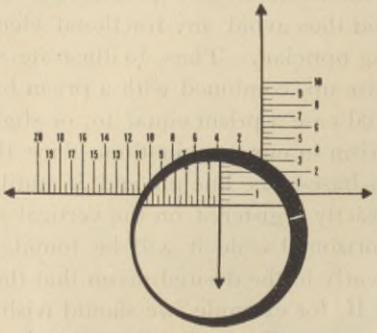
we would place P 4° in the trial frame with its base in, and rotate the base of the prism upwards until the vertical deviation registers exactly P 1° base up on the vertical scale, while at the same time the index line points to P $3\frac{3}{4}$° base in on the horizontal scale—thus showing a loss of only $\frac{1}{4}$° in the horizontal plane. If now we examine the trial frame we shall find the axis pointing to 15° on the protractor. Our prescription for the resultant prism would therefore read,

℞ O. D. P 4° base up ax. 15°.

If, however, this method should not satisfy the stickler for absolute accuracy, we may select one of two other methods. We can either place the required crossed prisms in the trial frame at the desired axes, rotate the entire trial frame, prisms and all, until the base line appears unbroken; then draw this axial line across the absolute center of the prisms with a pen, note the degree of rotation this axis indicates on the trial frame and at the same time read off the displacement along the scale. Or, by another method, we may secure a simple neutralization by placing a third prism in front of the other two, with its base opposing. If this be done accurately we can immediately note the degree of prism required together with its axis, and by simply reversing the base, record the resultant. (Any fraction remaining over can be noted on the scale, and added to the result.) These methods, however, require us to express our result in the smaller subdivisions of a degree. The result obtained, moreover, corresponds almost exactly to the mathematically accurate tables of Wallace, previously referred to. Either of these methods are likewise applicable in cases where we wish to secure the resultant of two prisms placed at *other* than right angles; and as well for the measurement of any prism at an oblique axis.



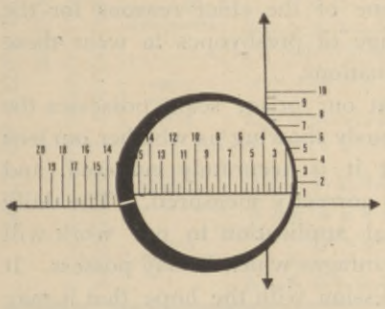
(Fig. 11.)



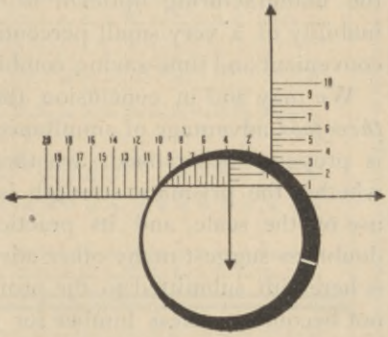
(Fig. 12.)

Reverting, however, to our first mentioned clinical method, which we have adopted as the most practical, we will proceed to illustrate the various positions which such a resultant prism may assume. For this purpose we will use our former example—a combination of P 1° vertical, and P 4° horizontal, the resultant of which is a 4° prism rotated 15° above or below the horizontal, and equivalent to a combination of P 1° vertical and P $3\frac{3}{4}$° horizontal.

A 4° prism with its base turned to the *left* and *up* will appear as in Fig. 11, or with its base to the *right* and *up* as in Fig. 12. If, however, the base is rotated to the *left* and *down*, we will have the appearance shown in Fig. 13, or with base to the *right* and *down* as in Fig. 14.



(Fig. 13.)



(Fig. 14.)

A table of these resultant prisms and their angles of rotation, based on this practical clinical method, is herewith appended, in order to avoid the necessity of each observer working out every combination for himself. (See page 272.)

We may neutralize these resultant prisms in one of two ways. We can either hold the spectacle lens horizontal, and read off the two prismatic strengths by the double deviation shown on the scale; or we can rotate the lens until the base line is unbroken, mark the axial line with a pen drawn across the absolute geometrical center of the lens, and read off the single resultant prism ordered. By laying the lens on a protractor we can note whether the axis is correct.

It may not be out of place to say a word in regard to the measurement of prisms when in combination with spheres and cylinders. In the first place, we must accurately adjust the optical center of our neutralizing lenses over the geometrical center of the combination to be tested before attempting to read off the prismatic strength, or we shall be disturbed by slight variations due to

artificial decentration. The exact optical center of a sphero-cylinder can be seen at a glance by looking through the lens at the junction of the vertical and horizontal base lines. This gives us the additional advantage of being able to compare the result found in one lens with the centering obtained in the other, which should be done with the greatest accuracy in order to detect the slightest *relative* differences, and especially any deviation in the vertical plane. This applies with particular force to the examination of bifocal lenses, the reading part of which I have several times found to have sufficient *relative decentration* to create an artificial hyperphoria of 1° for near, although the relation between the distance lenses was absolutely correct. In fact, I believe that this error of the manufacturing optician is one of the chief reasons for the inability of a very small percentage of presbyopes to wear these convenient and time-saving combinations.

We may add in conclusion that our prism scale possesses the *threefold* advantage of simultaneously showing us whether our lens is properly neutralized, whether it is accurately centered, and whether the prismatic strength is correctly measured. The daily use of the scale, and its practical application to our work will doubtless suggest many other advantages which it may possess. It is herewith submitted to the profession with the hope that it may not become "useless lumber for our attics," but may prove to be a useful addition to the practical working armamentarium of the oculist—and of the optician as well.

1504 Walnut Street.

TABLE OF EQUIVALENT PRISMS WITH THEIR RESULTANTS.

EQUIVALENTS		RESULTANTS	
Exact Vertical Prism	Approximate Horizontal Prism	Resultant Prism	Angle of Rotation
P ¼° ◯◯	P 1°	= P 1°	ax 15°
P ¼° ◯◯	P 1½°	= P 1½°	ax 10°
P ¼° ◯◯	P 2°	= P 2°	ax 8°
P ¼° ◯◯	P 3°	= P 3°	ax 5°
P ¼° ◯◯	P 4°	= P 4°	ax 4°
P ¼° ◯◯	P 5°	= P 5°	ax 3°
P ¼° ◯◯	P 6°	= P 6°	ax 2°
P ½° ◯◯	P ⅞°	= P 1°	ax 30°
P ½° ◯◯	P 1⅜°	= P 1½°	ax 20°
P ½° ◯◯	P 1⅞°	= P 2°	ax 15°
P ½° ◯◯	P 2⅞°	= P 3°	ax 10°
P ½° ◯◯	P 4°	= P 4°	ax 8°
P ½° ◯◯	P 5°	= P 5°	ax 6°
P ½° ◯◯	P 6°	= P 6°	ax 5°
P ¾° ◯◯	P ¾°	= P 1°	ax 45°
P ¾° ◯◯	P 1¼°	= P 1½°	ax 30°
P ¾° ◯◯	P 1¾°	= P 2°	ax 22°
P ¾° ◯◯	P 2¾°	= P 3°	ax 15°
P ¾° ◯◯	P 3⅞°	= P 4°	ax 11°
P ¾° ◯◯	P 4⅞°	= P 5°	ax 9°
P ¾° ◯◯	P 6°	= P 6°	ax 7°

EQUIVALENTS		RESULTANTS	
Exact Vertical Prism	Approximate Horizontal Prism	Resultant Prism	Angle of Rotation
P 1° ◯◯	P 1⅛°	= P 1½°	ax 40°
P 1° ◯◯	P 1½°	= P 2°	ax 30°
P 1° ◯◯	P 2⅝°	= P 3°	ax 20°
P 1° ◯◯	P 3¾°	= P 4°	ax 15°
P 1° ◯◯	P 4¾°	= P 5°	ax 12°
P 1° ◯◯	P 5⅞°	= P 6°	ax 10°
P 1½° ◯◯	P 1⅜°	= P 2°	ax 45°
P 1½° ◯◯	P 2½°	= P 3°	ax 30°
P 1½° ◯◯	P 3⅝°	= P 4°	ax 22°
P 1½° ◯◯	P 4⅝°	= P 5°	ax 17°
P 1½° ◯◯	P 5¾°	= P 6°	ax 15°
P 2° ◯◯	P 2¼°	= P 3°	ax 40°
P 2° ◯◯	P 3½°	= P 4°	ax 30°
P 2° ◯◯	P 4½°	= P 5°	ax 23°
P 2° ◯◯	P 5⅝°	= P 6°	ax 20°
P 3° ◯◯	P 2½°	= P 4°	ax 50°
P 3° ◯◯	P 4°	= P 5°	ax 35°
P 3° ◯◯	P 5⅛°	= P 6°	ax 30°
P 4° ◯◯	P 3°	= P 5°	ax 50°
P 4° ◯◯	P 4¼°	= P 6°	ax 42°
P 5° ◯◯	P 3⅛°	= P 6°	ax 60°

TABLE OF RESULTANT PRISMS AND THEIR EQUIVALENTS.

RESULTANTS		EQUIVALENTS	
Resultant Prism	Angle of Rotation	Exact Vertical Prism	Approximate Horizontal Prism
P 1°	ax 15°	= P ¼° ◯◯	P 1°
P 1°	ax 30°	= P ½° ◯◯	P ⅞°
P 1°	ax 45°	= P ¾° ◯◯	P ¾°
P 1½°	ax 10°	= P ¼° ◯◯	P 1½°
P 1½°	ax 20°	= P ½° ◯◯	P 1⅜°
P 1½°	ax 30°	= P ¾° ◯◯	P 1¼°
P 1½°	ax 40°	= P 1° ◯◯	P 1⅛°
P 2°	ax 8°	= P ¼° ◯◯	P 2°
P 2°	ax 15°	= P ½° ◯◯	P 1⅞°
P 2°	ax 22°	= P ¾° ◯◯	P 1¾°
P 2°	ax 30°	= P 1° ◯◯	P 1½°
P 2°	ax 45°	= P 1½° ◯◯	P 1⅜°
P 3°	ax 5°	= P ¼° ◯◯	P 3°
P 3°	ax 10°	= P ½° ◯◯	P 2⅞°
P 3°	ax 15°	= P ¾° ◯◯	P 2¾°
P 3°	ax 20°	= P 1° ◯◯	P 2⅝°
P 3°	ax 30°	= P 1½° ◯◯	P 2½°
P 3°	ax 40°	= P 2° ◯◯	P 2¼°
P 4°	ax 4°	= P ¼° ◯◯	P 4°
P 4°	ax 8°	= P ½° ◯◯	P 4°
P 4°	ax 11°	= P ¾° ◯◯	P 3⅞°

RESULTANTS		EQUIVALENTS	
Resultant Prism	Angle of Rotation	Exact Vertical Prism	Approximate Horizontal Prism
P 4°	ax 15°	= P 1° ◯◯	P 3¾°
P 4°	ax 22°	= P 1½° ◯◯	P 3⅝°
P 4°	ax 30°	= P 2° ◯◯	P 3½°
P 4°	ax 50°	= P 3° ◯◯	P 2½°
P 5°	ax 3°	= P ¼° ◯◯	P 5°
P 5°	ax 6°	= P ½° ◯◯	P 5°
P 5°	ax 9°	= P ¾° ◯◯	P 4⅞°
P 5°	ax 12°	= P 1° ◯◯	P 4¾°
P 5°	ax 17°	= P 1½° ◯◯	P 4⅝°
P 5°	ax 23°	= P 2° ◯◯	P 4½°
P 5°	ax 35°	= P 3° ◯◯	P 4°
P 5°	ax 50°	= P 4° ◯◯	P 3°
P 6°	ax 2°	= P ¼° ◯◯	P 6°
P 6°	ax 5°	= P ½° ◯◯	P 6°
P 6°	ax 7°	= P ¾° ◯◯	P 6°
P 6°	ax 10°	= P 1° ◯◯	P 5⅞°
P 6°	ax 15°	= P 1½° ◯◯	P 5¾°
P 6°	ax 20°	= P 2° ◯◯	P 5½°
P 6°	ax 30°	= P 3° ◯◯	P 5⅛°
P 6°	ax 42°	= P 4° ◯◯	P 4¼°
P 6°	ax 60°	= P 5° ◯◯	P 3⅛°

NOTE.—All the *axes* recorded in the above table refer to only one side of the horizontal plane, but apply as well to the other side. Thus, P 4° ax. 15° on one side, would read P 4° ax. 165° on the other side (ax. 30° would thus become ax. 150°). In any one of these positions the base may be either *up* or *down*. Each resultant prism may, therefore, occupy one of *four* positions: e. g., P 4° base *up* ax. 15°; P 4° base *down* ax. 15°; P 4° base *up* ax. 165°; P 4° base *down* ax. 165°.