A Report on Sample Binocular Serial #6268
Mark I, Model 2

Report on a comparison of a rigid binocular with the standard adjustable binocular and on Interpupillary Distance Setting Gauge

C.W. Shilling and W.S. Verplank

23 July 1943

APPROVED FOR PUBLIC RELEASE - DISTRIBUTION UNLIMITED

C.W. Shilling, Commander (MC) U.S.N., Medical Officer-in-Charge
Medical Research Laboratory
United States Submarine Base
New London, Conn.

July 23, 1943
MEMORANDUM

Memorandum To: Members and Liaison Officers of the Committee on Service Personnel, Liaison Officers and Project Directors of Committee Projects on Selection and Training of Fire Control 3/(R), Fatigue in Service Tasks; Selection and Training of Height Finder Operators.

From: Charles W. Bray

Subject: Report on a comparison of a rigid binocular with the standard adjustable binocular and on Interpupillary Distance Setting Gauge.

The attached report was produced at the Medical Research Laboratory, New London, Connecticut, under the general direction of Comdr. C. W. Shilling, (MC), U.S.N. Representatives of the Committee on Service Personnel cooperated in the studies and in the production of the report. This report is sent to you because of your probable interest in various types of binoculars and in methods of evaluating different kinds of visual equipment for use in the Services.
DISTRIBUTION LIST

Mr. John M. Stalnaker
Dr. George K. Bennett
Dr. Walter V. Bingham
Dr. Clarence H. Graham
Commander P. E. McDowell
Captain W. E. Moore
Dr. Morris S. Viteles
Dr. Leonard Carmichael
Lt. Comdr. Alvin C. Eurich
Dr. Wilfred J. Brogden
Lt. Col. John C. Flanagan
Lt. Col. Lester S. Hamel
Lt. Comdr. J. G. Jenkins
Lt. Comdr. C. M. Louttit
Col. Edmund Lynch
Lt. Comdr. S. S. Ballard
Commander M. E. Murphy
Major Karl M. Dallenbach
Captain H. M. Fisher
Lt. Col. H. O. Gardner
Dr. Leonard C. Mead

Lt. Comdr. J. C. O'Brien
Lt. Col. Marion W. Richardson
Lt. Col. Martin A. Severson
Captain Lybrand Smith
Commander J. H. Thach, Jr.
Commander John P. Womble, Jr.
Captain E. W. Brown
Dr. James B. Conant
Dr. Irvin Stewart
Col. G. R. Evans
Lt. Comdr. D. C. Beard
Mr. H. P. Bechtoldt
Major E. A. Leavins
Lt. J. A. Mets
Major J. B. Walker
Captain G. L. Crawford
Lt. Comdr. A. L. Shepherd
Major St. Claire
Lt. H. H. Strozier
Captain R. B. Thompson
SUMMARY

1. In compliance with Reference (a), extensive comparative field tests have been made of sample binocular, Serial #6268, Mark I, Mod. 2, manufactured by the Optical and Film Supply Company; and of the sample Interpupillary Setting Gauge.

2. The results of three different experiments lead to the following conclusions:

   (a) No significant differences were found between the performance of men using the sample rigid binoculars and the standard adjustable 7 x 50 binoculars under similar conditions. This conclusion is true not only of men whose focus and IPD approximated those built into the rigid binoculars, but also of those whose focal adjustments were divergent from those of the binoculars. There is evident a poorer performance on the part of men with IPD's markedly divergent from that for which the rigid binocular is set.

   (b) The sample Interpupillary Distance Setting Gauge has been found to be a simple and effective method of maintaining IPD setting in proper adjustment. Its use is recommended.

   (c) The focus and IPD adjustments which the average enlisted man makes for his eyes are highly variable and are not to be relied upon.
A Report on Sample Binocular Serial #6268

Mark I, Model 2

1. On March 19, 1943, a request was received by the Officer-in-Charge, Night Lookout Training School, U.S. Submarine Base, New London, Connecticut, from the Chief of the Bureau of Ships, requesting that a series of tests be made on a sample binocular which was enclosed. This binocular, manufactured by the Optical and Film Supply Company is an optically standard 7-50 binocular which lacks the standard adjustments for interpupillary distance and focus. An interpupillary setting gauge was included for evaluation.

2. An experimental procedure was set up designed to compare the performance of men of a wide range of interpupillary distance (IPD) and focus on these binoculars with their performance using standard 7-50 binoculars adjusted to their own eyes.

3. Apparatus and physical set-up.

A. Binoculars.

An examination of the rigid binocular showed that its IPD setting was 65 millimeters, and the fixed focus for each eyepiece, -3/4 diopter. Since it was considered desirable to make certain that test results could not be attributed to the characteristics of a particular pair of binoculars, four other pairs of binoculars, all Mark II, Model 2, 7-50 binoculars, manufactured by Bausch and Lomb, were employed in the experiments. Two of these, Serial #27596 and #28046, were employed without modification. The other two, #28227 and #28119, were provided with set-screws on the adjustable eyepieces, so that the focus could be fixed without the possibility of alteration during handling. An IPD setting gauge was made to fix the interpupillary adjustment of these binoculars at 65 mm. to conform with that of the sample binocular.

Two night alidades were also used. Since it was possible that either the standard or rigid binoculars might have advantages for particular purposes, the experiment was designed so that both types of binoculars could be compared not only when used freely, but also when mounted in a stabilizing fixture.

B. Range

A suitable range, allowing the setting of the binoculars at infinity, was arranged for between the roofs of the Submarine School
building and Bill Hall, Connecticut College. This distance over the Thames River, determined by fire control apparatus, is 2310 + 20 yards. The bearing of the range, from observer to target, is approximately West-Southwest.

C. Targets

A set of 12 targets was made consisting of Snellen broken circle figures painted with India ink on heavy Bristol board. The series of test objects, with data on visual angle subtended and corresponding visual acuity, is given in Table I.

<table>
<thead>
<tr>
<th>Target Number</th>
<th>Separation of Snellen Broken Circle (Inches)</th>
<th>Visual Acuity: Reciprocal of Visual Angle (Minutes) Subtended at Eye by Magnified Separation</th>
<th>Log VA (log 1/8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1/2</td>
<td>6.905</td>
<td>0.84</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>3.452</td>
<td>0.54</td>
</tr>
<tr>
<td>b</td>
<td>1 1/2</td>
<td>2.302</td>
<td>0.36</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1.726</td>
<td>0.24</td>
</tr>
<tr>
<td>3</td>
<td>2 1/2</td>
<td>1.381</td>
<td>0.14</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>1.146</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>3 1/2</td>
<td>.983</td>
<td>1.99</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>.861</td>
<td>1.94</td>
</tr>
<tr>
<td>7</td>
<td>4 1/2</td>
<td>.765</td>
<td>1.88</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>.689</td>
<td>1.84</td>
</tr>
<tr>
<td>9</td>
<td>5 1/2</td>
<td>.626</td>
<td>1.80</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>.574</td>
<td>1.76</td>
</tr>
</tbody>
</table>

The target series, it should be noted, is roughly logarithmic, covering almost the entire range of visual acuity which might be met. Selection of the series was determined by the following considerations:

1) The smallest targets should never be discriminated by the subject.

2) Targets should be most dense about the probable 50% correctly seen magnitude.

3) The size of the largest targets is necessarily limited by the practical limits of size. It was impossible to obtain a satisfactory target as large as 48 inches in diameter.
4) The actual target measurements should be such that the 
targets could be easily made.
5) It was not anticipated that the binoculars would be fully 
effective at their rated 7 power. Consequently, targets 
were most closely spaced corresponding to a visual acuity 
of less than 1.00

The Bristol boards were fixed to 4-foot squares of 
plywood, which were painted white. These plywood squares fitted into a 
large rotatable holder, so that the targets could be rapidly shifted by a 
manipulating crew. Rotation of the targets in the vertical plane permitted 
rapid changing of the direction of the break in the Snellen figure. Rotation 
of the holder in the horizontal plane permitted shifting of the target sheets 
out of view of the subjects, and allowed control of the duration of exposure 
of the target.

D. Personnel

The experimental program was under the general direc-
tion of Comdr. T. L. Willmon (MC) USN. It was immediately in charge of 
W. S. Verplanck, Ph.D., N.D.R.C., psychologist attached to the Medical 
Research Laboratory. In the first part of the experiment, the latter served 
in the field tests, and in the second part, Lt. (j.g.) E. W. Davis, USNR, 
served as field director. C. W. Watson assisted in the statistical treat-
ment.

Three enlisted men served as recorders on the Subma-
rine School roof. A party of five enlisted men were stationed on the Bill 
Hall roof to operate the targets and to run the test series.

E. Subjects:

A total of 97 subjects were tested completely. Of these 
75 were employed during the first part of the experiment, and 22 during the 
second. The first group was selected at random from the men receiving 
the physical examination for Submarine School and were not, as a group, 
experienced in the use of binoculars. Indeed a large number had not 
previously examined a pair of binoculars. The second group, drawn from 
deck forces of submarines, were experienced lookouts.

Procedure:

Part I.

At the beginning of each test period, four men were selected 
at random from the group of men awaiting physical examination for
submarine duty. Their names, rates, experience and other pertinent data were recorded, and the subjects were carefully instructed in the nature of the experiment and the importance of their performance.

The men were then taken to the roof of the Submarine School, and were each given standard binoculars which they examined, noting the adjustments possible. Their measured IPD's were set, and each man was instructed in the proper procedure of focusing for each eye. They focused their binoculars, and a record was made of the result. Final instructions, stressing the desirability of guessing, and outlining the procedure by which the subjects signalled the position of the broken circle to the recorders, insured that the men were well acquainted with their task.

During this time, radio communication was established with the target working party. Communication was maintained throughout each experimental period, to insure coordination of the series.

The four subjects took position for the first series, One started in each of the following positions, using the binoculars specified:
1. south end of roof; standard binoculars, used free.
2. south center of roof; rigid binoculars, mounted.
3. north center of roof; standard binoculars, mounted.
4. north end of roof; rigid binoculars, used free.

A practice series, consisting of 10 presentations of the largest target, was given. On the completion of this, the recorders checked each focus and IPD adjustment of the standard binoculars, and the first test series was begun.

Each series consisted of 48 trials, composed of one 8 to 10 second presentation in each of the four positions (right, down, left and up) of each of the 12 targets. In all, 20 to 25 minutes were required for these 48 trials. The series followed a randomized sequence. No subject was run through the same series twice.

At the completion of the first series, a ten-minute rest period was given. The subjects then moved to the next pair of binoculars to be used, and the focus and IPD adjustments were set for those using standard binoculars in preparation for the second series.

Four series were run each half day, so that each subject used both rigid and standard binoculars under both mounted and free conditions.
With few exceptions, the weather conditions under which the experiments were run were favorable. On one or two days, the visibility was only fair, but on most days it was excellent.

An attempt was made to balance the number of times each pair of binoculars was used in each position, but weather and other uncontrollable factors largely concerned with communication made it impossible to do this satisfactorily.

Part II

In the second part of the experiment, there were only minor changes in the procedure. Enumerated, they are as follows:

1. Twenty-two subjects were employed, all of whom had had several years' experience with the use of binoculars.
2. Each man determined his own IPD adjustment by manipulation of the binoculars.
3. Only 6 targets were used, and each one appeared 8 times in the series of 48 trials. In the earlier section of this part of the experiment, targets a, b, 2, 3, and 4 were used, and in the later part, b, 2, 3, 4, 5, and 6.
4. Each subject was run through the complete series twice.
5. No alidades were used at any time.

Results:

1. Treatment of the data from the first part of the experiment consisted of the following steps:
   a. The data sheet of each man was corrected, and the number of "right", "wrong", and "don't know" responses for each target in each of the four series was determined.
   b. The sums of these figures were determined for each pair of glasses in each position, and from the results the percent correct response for each target was calculated by the formula \( R = \frac{1}{3} W \). These percentage scores were plotted against the logarithm of the reciprocal of the visual angle subtended by the separation of the broken circle in each target. This permits direct measurement of visual acuity.
c. The following plots were made, and are presented:

1) Frequency of correct response for all men on standard binoculars used mounted and free; and on rigid binoculars used under both conditions. (Figure 1)

2) Frequency of correct response for each of the two following groups on each of the four positions of the binoculars:
   a) Men focusing both eyepieces of the binoculars within the range -1/4 to -1 1/4 diopters (n=43)
   b) Men focusing either eyepiece of the binoculars outside that range (n=32). (Figures 2 and 3)

3) Frequency of correct response for each of the three following groups on each of the four positions of the binoculars:
   a) men with IPD's within the range 63-67 mm. (n=59).
   b) those with IPD's of 62 mm. or less (n=10).
   c) those with IPD's of 68 mm. or more (n=6). (Figures 4 and 5)

4) Other similar plots were made during the preparation of this report, seeking to establish whether the particular pair of binoculars used produced any differences. No differences not evident in Figures 1, 3, and 5 appeared.

2. The data of Part ii of the experiment were treated similarly to the above. Figure 6 gives the results for this group of men, for each and both of the two series used. Figure 7 compares this group with the earlier group.
Discussion:

In reading and interpreting the results presented, it should be noted that the curves displaced to the left represent better performance than do those to the right. The slope of each curve reflects the variability of observation using those glasses. The antilog of the point on the abscissa opposite the 50% point of the curve is a satisfactory measure of visual acuity derived from that group of observations. Other percentages, however, may be employed.

In Table II may be found the visual acuities obtained by reading from the visually fit ogives, together (a) with the corresponding visual angle, (b) the size of an object which such a visual acuity would just make discriminable at 10,000 yards, and (c) the range at which each permits the discrimination of a one-foot square.* The last two items mentioned are listed in the columns headed, respectively, "Object Size at 10,000 yds." and "Foot-square Range", in the following table.

Table II.

Mean Visual Acuities for 75 Men
Employing Rigid and Standard Binoculars
Used Both Freely and Mounted

<table>
<thead>
<tr>
<th>Visual Acuity</th>
<th>Visual Angle</th>
<th>Object Size at 10,000 yds.</th>
<th>Foot-Square Range</th>
<th>Percent Maximum Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid Mounted</td>
<td>1.50</td>
<td>.67</td>
<td>69.7</td>
<td>1731</td>
</tr>
<tr>
<td>Standard Mounted</td>
<td>1.45</td>
<td>.69</td>
<td>71.9</td>
<td>1668</td>
</tr>
<tr>
<td>Rigid Free</td>
<td>1.35</td>
<td>.74</td>
<td>77.4</td>
<td>1551</td>
</tr>
<tr>
<td>Standard Free</td>
<td>1.29</td>
<td>.75</td>
<td>81.0</td>
<td>1381</td>
</tr>
</tbody>
</table>

Attention is drawn to the following observations to be drawn from the figures:

Figure 1: The four ogives for all men clearly indicate that best performance was obtained by use of rigid binoculars mounted in an alidade. The standard binoculars, similarly mounted, give results almost as satisfactory. Binoculars which the user is permitted to handle freely give

* This offers a very crude indication of the relative effectiveness of the various binoculars.

10
Figure 6: Graph showing different series of data points. The graph includes a legend indicating 'Rigid Binoculars' and 'STD Binoculars,' with 'KEY' denoting the axes. The graph compares 'A First Series' and 'B Second Series,' with 'C Combined Series' also plotted. The graph's axes are labeled with logarithmic scales, indicating data correlation and comparison across series.
less satisfactory performance, but again, the rigid binoculars are some-
what better.

Figure 2: The results for men whose focus is divergent from that
set in the rigid binoculars conform with those for men whose focuses
closely approximate that of the binoculars. No significant differences are
evident. The conclusion is forced that the set focus does not interfere
with the performance of men who, given the opportunity to select the best
focus, choose one quite different from that built into the binoculars.

Figure 3: The same curves are plotted in different array, showing
the similarity of results from both groups to those of all subjects.

Figure 4: The results for men of extremes in interpupillary distances
are more positive. Clearly, in all cases, the men with interpupillary dis-
tances approximating the set 65 mm. perform better than do those with
extreme IPD's. However, this is true not only of the rigid binoculars, but
also, to a lesser extent, of the standard binoculars.

It is especially noteworthy to observe that the advantage of these
with the middle range of IPD's is least with standard binoculars used free,
and greatest with rigid binoculars used free. Figure 5 presents the same
curves in different apposition. The small numbers of men with extremely
deviant IPD's make these results less reliable than those on men with
deviant focuses.

Figure 6 and Figure 7: The results of the second part of the experi-
ment, conducted on experienced subjects, conform with those of the earlier
part of the experiment in detail. There is clearly no evidence of superior
performance which may be attributed either, within the group, to the use of
standard adjustable binoculars (Figure 6), or, between these men and the 75
men of Part I (Figure 7), to experience in the use of binoculars.

Supplementary Experiment

In view of the striking similarity of results from all binoculars,
which might be attributed, at least in part, to inaccuracy of adjustment of
the standard binoculars, a statistical check was made of the accuracy with
which the individual is able to set his own focus and interpupillary distance.

The following procedure was employed:

1. Five measures of anatomical IPD were made:

2. Two measures of the physiological IPD were made:
3. The subject was instructed to focus the right barrel of the binoculars on a distant object. Focusing was performed by adjustment from the extreme positive setting to the point of best focus. This was recorded and the procedure repeated four times, with each setting recorded.

4. This procedure was repeated for the left eye.

5. The average focus for each eye was estimated from the data, and the binoculars set at that focus. The barrels were now adjusted so that the IPD adjustment was the largest possible, and the subject was instructed to look through the binoculars at the same distant object, and to bring the binocular barrels together until the binocular fields were most satisfactorily fused. This setting was recorded. The binoculars were now adjusted to the narrowest IPD possible, and the same instructions given. This procedure was repeated 3 times, giving 6 measures in all. All measures were made by PhM 1/c Cooper.

Means and standard deviations were calculated for all of the measurements on each man, and means and standard deviations of those measures calculated, as well as intercorrelations between the various measures of IPD. Final results are given in Table III.

The high correlation between physiological and anatomical IPD, and the moderate correlation between each and self-adjusted IPD seems to indicate that neither has any subjective advantage over the other.

Table III

a. Focus

<table>
<thead>
<tr>
<th></th>
<th>MM</th>
<th>σM</th>
<th>Mσ</th>
<th>σσ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Eye</td>
<td>-1.19</td>
<td>.73</td>
<td>.54</td>
<td>.12</td>
</tr>
<tr>
<td>Left Eye</td>
<td>-1.04</td>
<td>.44</td>
<td>.45</td>
<td>.25</td>
</tr>
</tbody>
</table>

b. IPD

<table>
<thead>
<tr>
<th></th>
<th>MM</th>
<th>σM</th>
<th>Mσ</th>
<th>σσ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ana. IPD</td>
<td>64.97</td>
<td>2.68*</td>
<td>.41</td>
<td>.23</td>
</tr>
<tr>
<td>Self-adjusted IPD</td>
<td>64.46</td>
<td>2.85*</td>
<td>2.01</td>
<td>1.16</td>
</tr>
<tr>
<td>Physiological IPD</td>
<td>64.52</td>
<td>2.75*</td>
<td>----</td>
<td>----</td>
</tr>
</tbody>
</table>

* M has been calculated, for convenience, on the basis of all measures of 60 mm. or greater. Therefore, the true standard deviation is larger. N's are, respectively, 49, 47, and 47.
c. Correlations

Variables Pearson "r"

Self-Adjusted IPD - Anatomical IPD .65
Self-Adjusted IPD - Physiological IPD .68
Anatomical IPD - Physiological IPD .99

It is obvious from these results that the individual is not able to adjust a pair of binoculars with any degree of accuracy. Both with respect to focus and with respect to interpupillary distance, the individual is highly variable in what he considers a satisfactory adjustment. For this reason, it is strongly urged that such determination be made of the individual accurately, and under supervision, and that these settings be maintained by the individual thereafter. Such lack of precision may indeed account for our results for, in both parts of this experiment, the focus was determined by the individual, and in part 2 the IPD was similarly determined.

Setting of Fixed Binoculars; Interpupillary Gauge

The mean settings of focus and measurements of IPD make it possible to evaluate the adjustments built into the rigid binoculars. Table III presents the mean settings of both the 50 men in the supplementary experiment, and of the 75 men in the first part of the experiment.

Table IV

Means of IPD and Focus

<table>
<thead>
<tr>
<th>IPD Measurements</th>
<th>Mean (mm.)</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomical: 75 subjects</td>
<td>64.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Anatomical: 50 subjects</td>
<td>65.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Physiological: 50 subjects</td>
<td>64.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Self-Adjusted: 50 subjects</td>
<td>64.5</td>
<td>2.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Focus</th>
<th>Right Eye</th>
<th>Left Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (diopters)</td>
<td>σ</td>
</tr>
<tr>
<td>75 subjects</td>
<td>-1.19</td>
<td>.73</td>
</tr>
<tr>
<td>50 subjects</td>
<td>- .75</td>
<td>.81</td>
</tr>
</tbody>
</table>
These measures are close to the 65 mm. IPD and -.75 diopter focus adjustment which are built into the fixed binoculars. It is possible that a fixed focus of -1.00 diopters might prove slightly more satisfactory, but the difference, in view of the variability of the data is negligible.

The interpupillary gauge proved most satisfactory in all respects. As indicated by the absence of any difference in results between the rigid binoculars provided by the Bureau and the standard binoculars adapted by use of the gauge and eyepiece set screws, the gauges effectively hold fixed an interpupillary distance setting. No inconvenience is found in using them, although it should be noted that the gauges for the larger IPD's must be somewhat differently designed if they are to fit satisfactorily on the binoculars.

The use of such gauges is strongly recommended.

Discussion and Recommendations

These results then with one exception, indicate that the use of fixed focus and fixed IPD binoculars may possess certain advantages, whether the binocular is mounted or held by hand. This finding is clearly not what might be expected by a prior reasoning, and indeed, seems contrary to experience in the field.* Without attempting to explain away these results, certain reasons may be adduced for them. First, on the basis of our findings, the individual if left to himself will not necessarily adjust the binoculars suitably. The individual simply is not able to make a precise setting. Second, there is a probability that the adjustments made at the beginning of a period may become lost through handling. This suggestion derives from the fact that "standard free" binoculars are more inferior to "rigid free" binoculars than are "standard mounted" to "rigid mounted".

It may be concluded that although standard binoculars should give optional performance, they do not do so. Presumably, this may be attributed to improper handling, and use.

CERTAIN PROBLEMS HAVE NOT BEEN TOUCHED IN THE PRESENT EXPERIMENT, WHICH DEALT WITH 20-MINUTE PERIODS OF VISUAL ACUITY DETERMINATIONS, THESE PROBLEMS INCLUDE FATIGUE EFFECTS, USE IN SCANNING, AND USE AT NIGHT. With respect to fatigue, it might be noted that the 20 minute test periods in the present experiment

* If one looks at a distant object through the rigid binoculars and through standard binoculars properly focused, the object seems much clearer through the latter.
include at least 8 minutes of observation through binoculars. How closely this compares with the total amount of time binoculars are used during a half-hour lookout watch is not known.

On the basis of our data, however, the following recommendations are made:

1. Under the conditions of this experiment, fixed focus binoculars are more satisfactory than adjustable focus binoculars. On the basis of 50 men examined here, -1.00 diopter is suggested as a satisfactory setting.

2. Fixed IPD binoculars are very probably more satisfactory than adjustable binoculars, provided that the fixed IPD approximates within 1 or 2 millimeters the IPD of the man using them. It is suggested that binoculars incorporating stops at three interpupillary distances may profitably be manufactured on the basis of the distribution of IPD’s found in our present population; 62, 64, and 67 mm. are suggested.

3. In the absence of such fixed binoculars, it is suggested that each man using binoculars be provided with an interpupillary gauge such as that developed by the Bureau, which will hold in adjustment to his own IPD any pair of 7-50 binoculars he might use.

4. It is further suggested that each man using binoculars make, under supervision, a minimum of ten determinations of the best focus for each eye, that the mean of these determinations be etched on his IPD gauge, and that he be provided with friction tape, so that on each occasion when he uses binoculars he may set his own mean focus and tape the binoculars so that it will not be lost.