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Establishment of norms in specific areas of the visual field for critical fusion frequency as determined by a modified stroboscope

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Abstract

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Degree Type

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Committee Chair

Detleff T. Jans

Subject Categories

Optometry

ESTABLISHMENT OF NORMS IN SPECIFIC AREAS OF THE VISUAL FIELD FOR CRITICAL FUSION FREQUENCY AS DETERMINED BY A MODIFIED STROBOSCOPE.

CLINICAL YEAR THESIS

BY

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1960

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STATEMENT OF THE PROBLEM

It is the purpose of this study to establish norms for critical fusion frequency in specific areas of the visual field by a modified stroboscope. The purpose of the establishment of such norms is to make it possible to apply the technique clinically in visual fields analysis.

RESEARCH OF THE LITERATURE FOR WORK DONE WITH FLICKER FUSION FREQUENCY FIELDS.

Some of the very early investigators (experimentally) were Plateau, Talbot, Ferry and Porter, along with numerous others. However, since those very early days, there have been many investigators who have worked with flicker fusion fields on a clinical basis.

Many studies have been made of the effects of disease processes on the critical fusion frequency (c.f.f.). Phillips[1] studied the effects of intracranial tumors on the C.f.f. In 1933 Phillips[2] made the first study of flicker fields on patients. He restricted his tests to 17 areas of the visual field, and even today his targets are considered adequate and his controls good. He found that 2.5 cm. targets gave a central flicker fusion frequency (f.f.f.) of 43 flashes per second, with gradual decrease toward the periphery, while similar 3.5 cm. targets gave a central f.f.f. of 49, with increase in 10-degree peripheral intervals to 56, 50, 44 and 41. He found a decrease in f.f.f. in eight chiasmal and two parietal brain tumors. The two parietal cases had normal visual acuity and fields.

F.f.f. has been measured experimentally for some years, and much of the clinical application of the principal has been developed and refined by Riddell[3], Weekers and Rousel[4], Mayer and Sherman[5], and in more recent years the major portion of the work can be ascribed to the work of Miles.[6]

In 1938 Miles[7] found that the f.f.f. is easily determined in patients who are inept in other subjective tests. He states that the f.f.f. test may prove an aid in determining whether certain apparently normal eyes with normal acuity are defective.

Two accounts of f.f.f. in amblyopia ex anopsia occur in the literature.[8] Lohmann in 1908, reported that in a young woman, aged 23 years, with amblyopia ex anopsia, the central f.f.f. in the amblyopic eye was 46 per second, compared to 34 in the normal eye.

Visual acuity was: O.D. 5/4; O.S. 5/25.

Specifically his results were:

O.D.	Central	15	30	45 (Peripheral Retina)
	34	43	54	57
O.S.	46	43	43	42

Teraskeli[9] reported in 1934 that, in 21 out of 50 cases of amblyopia ex anopsia, the central f.f.f. of the amblyopic eye was equal to that of the periphery 10 degrees out. She concluded that the central area (fovea) is lacking in the affected eye, leading to strabismus.

The more recent work of Miles[10] cites that f.f.f. was determined in 44 patients with amblyopia ex anopsia. He concludes that the central area of the amblyopic eye performed like the peripheral retina because the central area had a higher f.f.f. than normal. This suggested to him that there was suppression of the central cones.

With the equipment that he used for his experiment Miles found that normal f.f.f. was 45 flashes per second centrally, and 50 on the 8 degree temporal retina.

Miles[11] in 1949 showed in a study that the critical fusion rate decreased abruptly with decrease in pupil size. Later work seems to indicate that this might not be the case. In 1950 Miles[12] showed by experiment that the change in f.f.f. with pupil size described in earlier experiments in the past was due to insufficient time permitted for complete adaption to the reduced illumination. In the same data described just previously it was shown that advanced age does not necessarily depress f.f.f.

In a later paper[13] Miles states that the eye is more sensitive to f.f.f. in the periphery (10 to 30) than centrally, and f.f.f. is therefore more likely to detect defects from diseases which affect the peripheral field first.

Tachistoscopic tests differ from f.f.f. in that perception of objects exposed for brief intervals can improve with training, particularly in the peripheral retina. F.f.f. is not altered either by training or fatigue. Tyler[14] in 1947 reported tests on 600 subjects who remained awake from 30 to 60 hours without change in f.f.f.

Lythgoe and Tansley[15] (1944) found day to day variation of f.f.f. to be 2.9 percent in the worst subject; and 0.6 percent in the best. Brozek and Keys[16] (1944) found readings in 56 normal adults to vary less than one percent from day to day. Curves on the variation of f.f.f. with intensity, area, light-dark phase, distance from fovea, and so forth show parallel curves in all normal individuals.

Riddell[17] (1936) reported flicker fields on 58 patients, concluding, "the flicker method is to have a place in ophthalmic work". In the case of one patient he found a total hemianopsia by f.f.f. where ordinary field showed only a temporal slant. He believed one should not expose one retinal area more than three seconds to flicker, because fatigue might eliminate the flicker sensation. However, as noted in the above the fatigue factor was later ruled out.

Mayer and Sherman[18] (1938) reported on normals using a neon tube target, 1 to 3 degrees in diameter, at a distance of 25 cm. on a perimeter.

Werner[19] (1942) tested 20 children with brain injury, and found a decreased f.f.f. Enzer[20] (1942) found in 45 normals a central f.f.f. of 45, while 13 hypothyroid patients had 36.6 (33 to 41); in four patients treated with methyl testosterone it changed from 43 to 46.6; while benzedrine increased it three flashes per second.

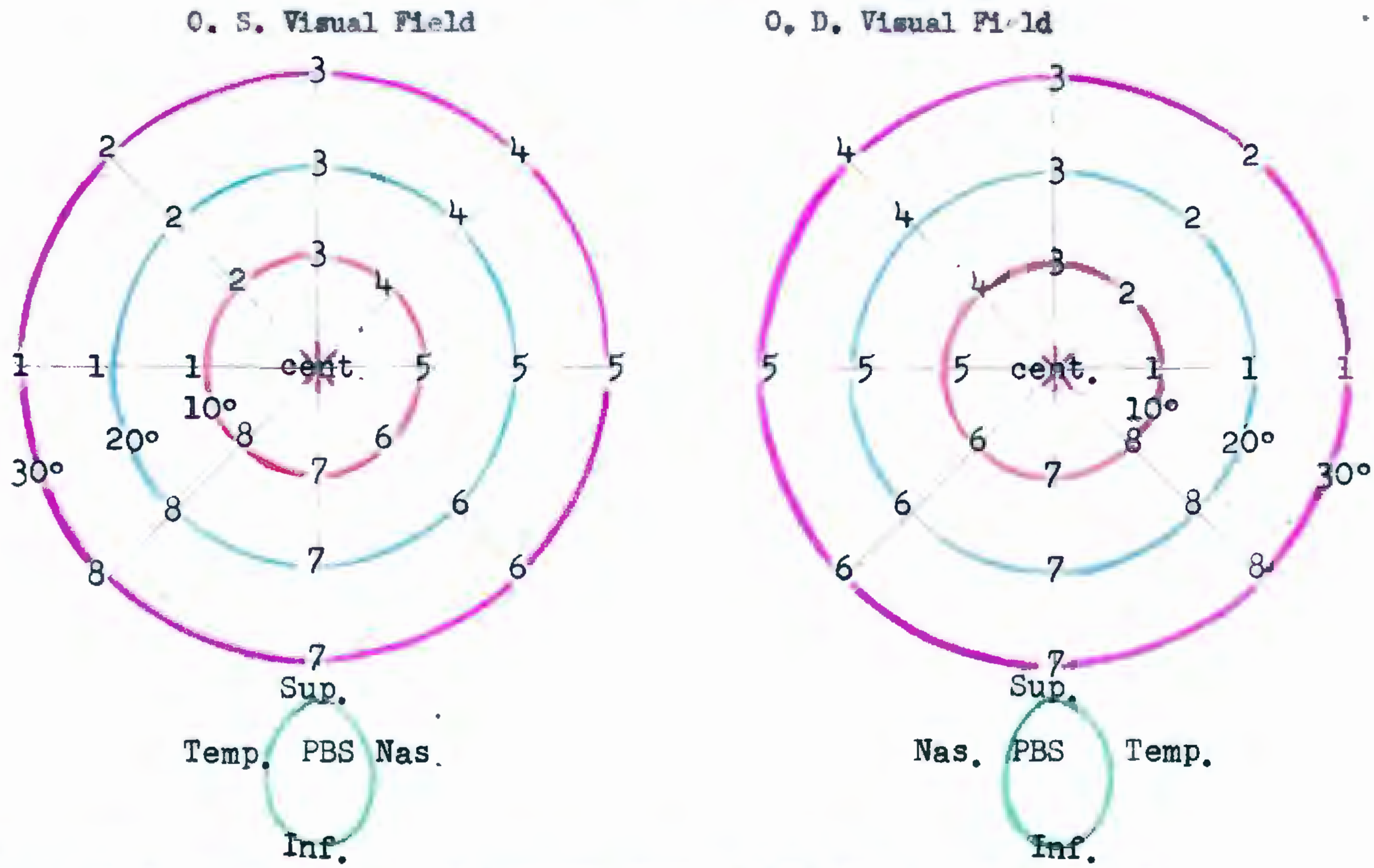
Weekers[21] (1946, 1947, 1948) reported clincal studies of such conditions as nicotinic neurities, glaucoma, compression of optic pathways and detached retina. He used an improved sector disc method in which the target was mobile about a red fixation light. He tested 26 different areas of the 30 degree visual field, with targets from 3 to 7 degrees at a distance of 100 cm.

BRIEF ACCOUNT OF DATA, METHODS AND PROCEDURES.

A random sampling of patients with no observable ocular pathology was used in this study. A total of 40 subjects were examined by the modified Stroboscopic method within the age range of 10 to 67 years with the greatest frequency in the age group of 20 to 35 years of age.

The patient's habitual prescription was not worn during the test unless the unaided acuity was so poor that the patient could not see the central fixation target.

EXAMPLE RECORDING SHEET



e.g.- stroboscope readings for temporal area of 10° ring (position #1) of O.S. corresponds to temporal area of 10° ring (position #1) of O.D. visual field.
- similarly, the indicated temporal position of the O.S. P.B.S. corresponds to the indicated temporal position of the O.D. P.B.S.

DETAIL ACCOUNT OF METHODS, PROCEDURES AND SOURCE OF DATA.

A portable stroboscope (manufactured by the General Radio Corporation, Cambridge 39, Mass.) was used in this study. It is called the "Strobotac". Previous adaptation of the stroboscope used was accomplished by removing the flash tube and the reflector, and soldering the ends of a 6 foot, form wire cable to the lugs on the flash tube socket. The 4 prongs of the flash tube itself were then soldered to the appropriate wires of the cable. The last 2 or 3 feet of the cable were passed through a rigid metal tube or rod to form a wand by means of which the light can be controlled in its movement in front of the tangent screen. The bulb (flash tube) was then enclosed by a discarded retinoscope handle with a 24 mm. circular openeing over a portion of the bulb. This opening was covered with translucent paper (tea bag material) to diffuse the light.

The patient was seated one meter away from a one meter black tangent screen. The wand was held at the center of the tangent screen and the patient was shown what was meant by flicker. He was then instructed to tap when the flicker was first perceived. While taking the center reading the patient looked at the wand, but for all other readings, fixation remained at the screen's central fixation point. The test was performed in a room of 7 ft. candles illumination while the patient had the unexamined eye occulded. It should be mentioned at this point that the standard technique for light adaptation of the eye under test was used.

The procedure heretofore described was employed in the 8 cardinal meridians at intervals of 10, 20 and 30 degrees from the central fixation point. The obtained findings were then recorded on a data sheet of the type found on page #6.

The same procedure was used in obtaining the four readings of the P.B.S. The only variation was that the patient's P.B.S. was not first plotted but instead we used the normal outlined P.B.S. on the tangent screen.

The statistical compilation of the thesis included calculations for the mean, standard deviation and probable error.

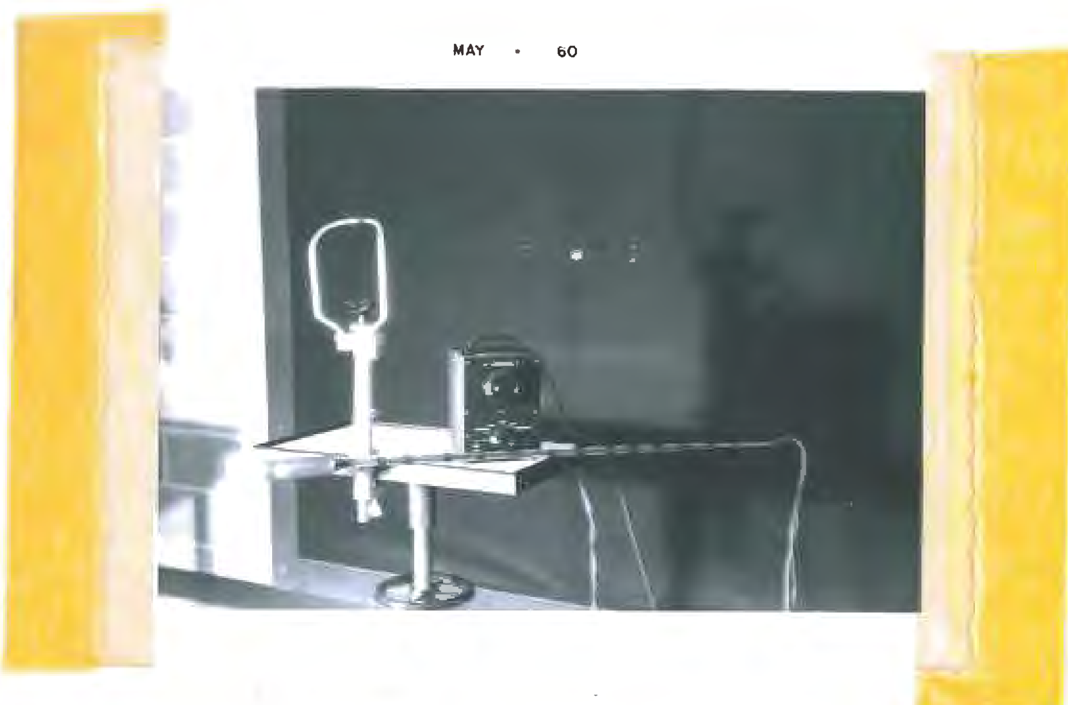
Formulae used:

(A) Mean: $\frac{\text{sum of } x}{N}$

(B) Sigma: $\frac{1}{N}\sqrt{N \text{ sum } fd^2 - (\text{sum } fd)^2}$

(C) P.E. : 2/3 sigma

Raw data readings for identical corresponding positions of O.D. and O.S. visual fields were grouped together as indicated by the examples given on page 6.



Instrumentation showing adapted stroboscope, wand, head rest and tangent screen in the background.

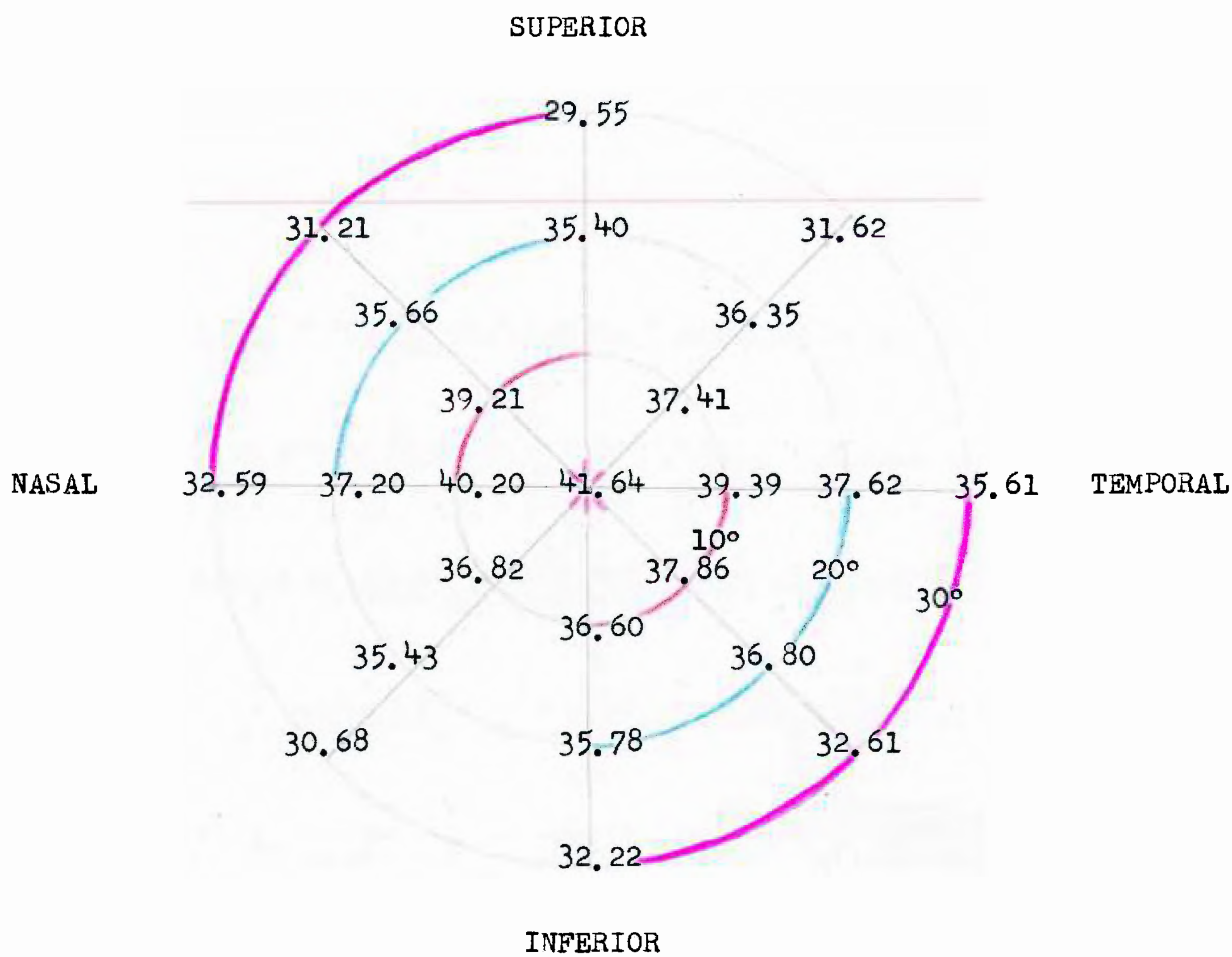
LISTED MEANS, STANDARD DEVIATIONS, AND PROBABLE ERRORS.

MERIDIANS		PERIPHERAL 10°	PERIPHERAL 20°	PERIPHERAL 30°	CENTRAL
1	mean:	39.39	37.62	35.61	41.64
	S.D:	3.48	3.93	4.18	3.78
	P.E:	2.32	2.62	2.78	2.46
2	mean:	37.41	36.35	31.62	
	S.D:	4.26	4.45	4.50	
	P.E:	2.84	2.96	3.00	
3	mean:	37.80	35.40	29.55	
	S.D:	4.22	3.63	5.30	
	P.E:	2.80	2.42	3.52	
4	mean:	39.21	35.66	31.21	
	S.D:	3.75	4.39	5.98	
	P.E:	2.50	2.92	3.98	
5	mean:	40.20	37.20	32.59	
	S.D:	2.52	3.63	4.32	
	P.E:	1.68	2.42	2.88	
6	mean:	36.82	35.43	30.68	
	S.D:	4.07	4.57	4.78	
	P.E:	2.70	3.04	3.18	
7	mean:	36.60	3[illegible].78	32.22	
	S.D:	3.99	5.00	4.48	
	P.E:	2.66	3.32	2.98	
8	mean:	37.86	36.80	32.61	
	S.D:	4.84	4.21	4.31	
	P.E:	3.22	2.80	2.86	

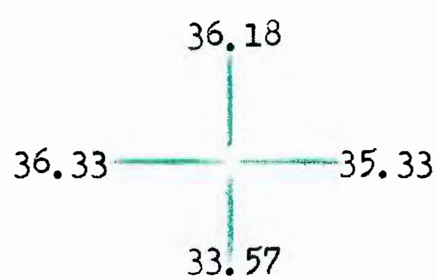
PHYSIOLOGICAL BLIND SPOT

	Sup.	Inf.	Temp.	Nasal
mean:	36.18	33.57	35.33	36.33
S.D:	4.22	4.86	4.47	3.78
P.E:	2.82	3.24	2.98	2.52

CALCULATED C.F.F MEANS PLOTTED ON A FIELD CHART.

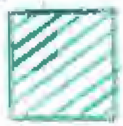


C.F.F. MEANS PLOTTED ON HORIZONTAL AND VERTICAL LIMITS OF P.B.S.



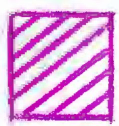
The following graphs illustrate the frequency distribution for each specifically numbered or indicated area as found on page 6. The horizontal axis of each graph, unless otherwise stated, represents the grouped raw data readings as obtained directly from the strobotac indicator. The vertical axis represents the frequency of the intervals. These readings were later converted into c.f.f. units of revolutions per second by a factor of $10^2/60$ for the mean calculations. (The results of which are shown on pages 10 and 20)

Color Code of Graphs:

P.B.S. Boundaries 

10° positions 

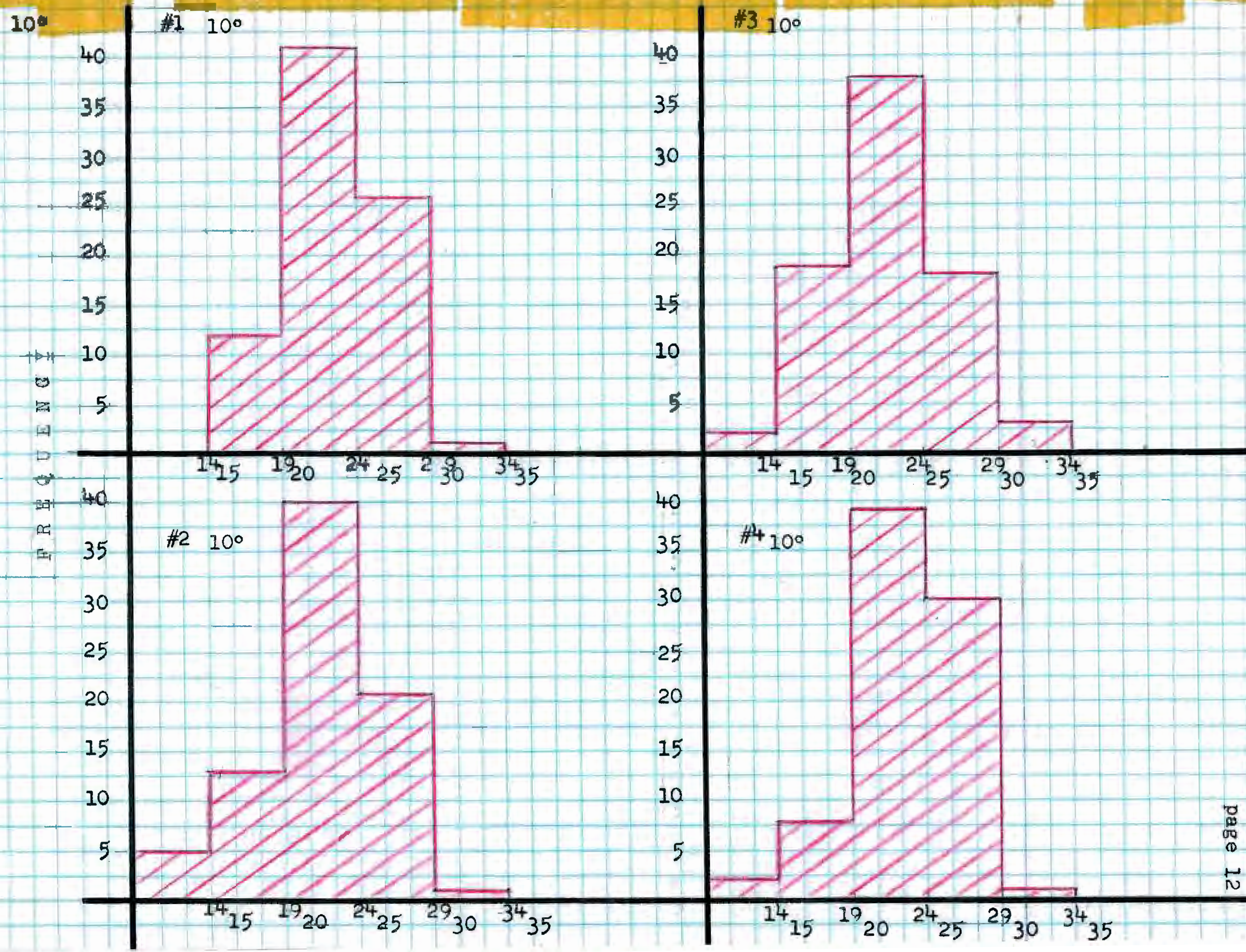
20° positions 

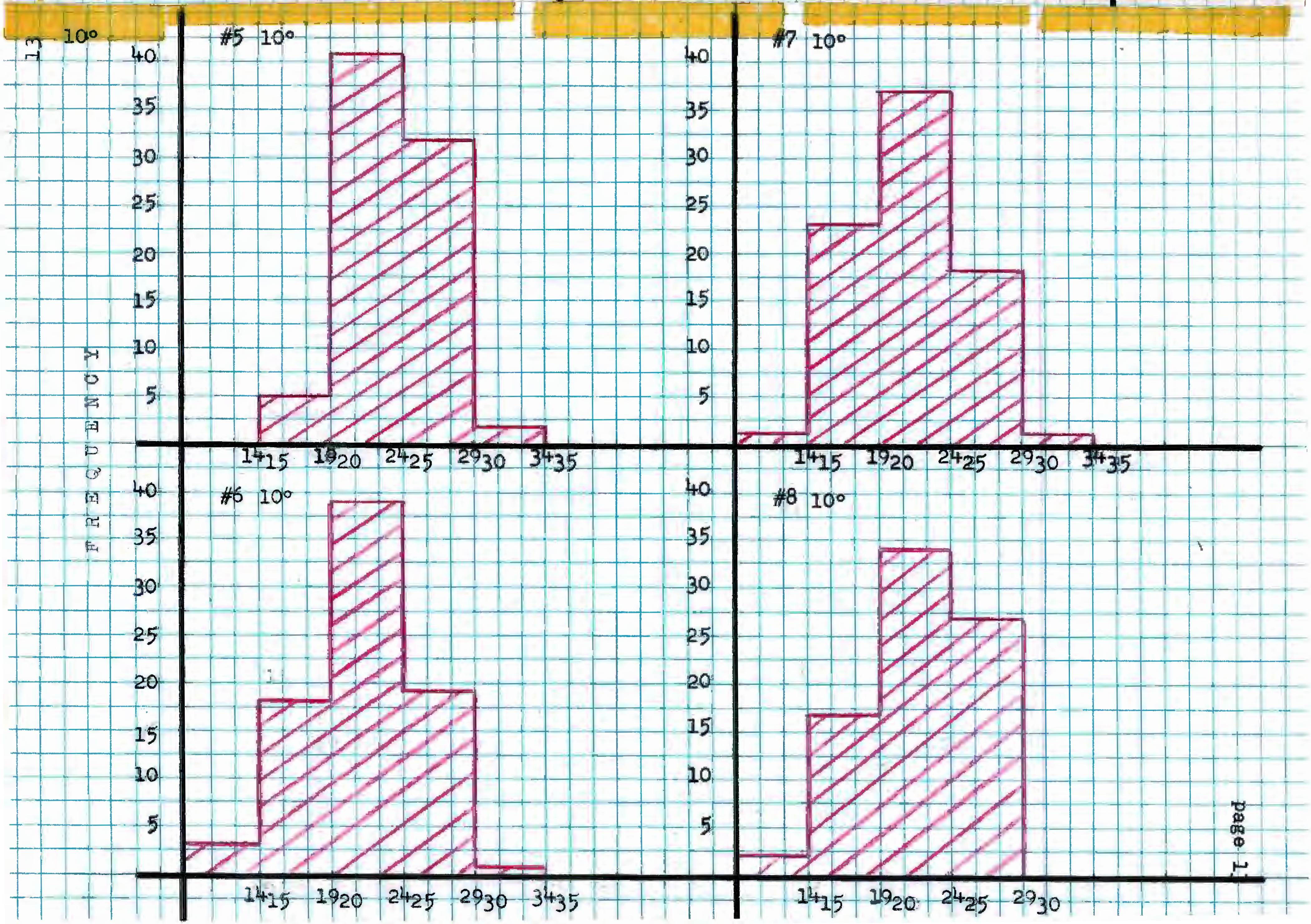
30° positions 

central position 

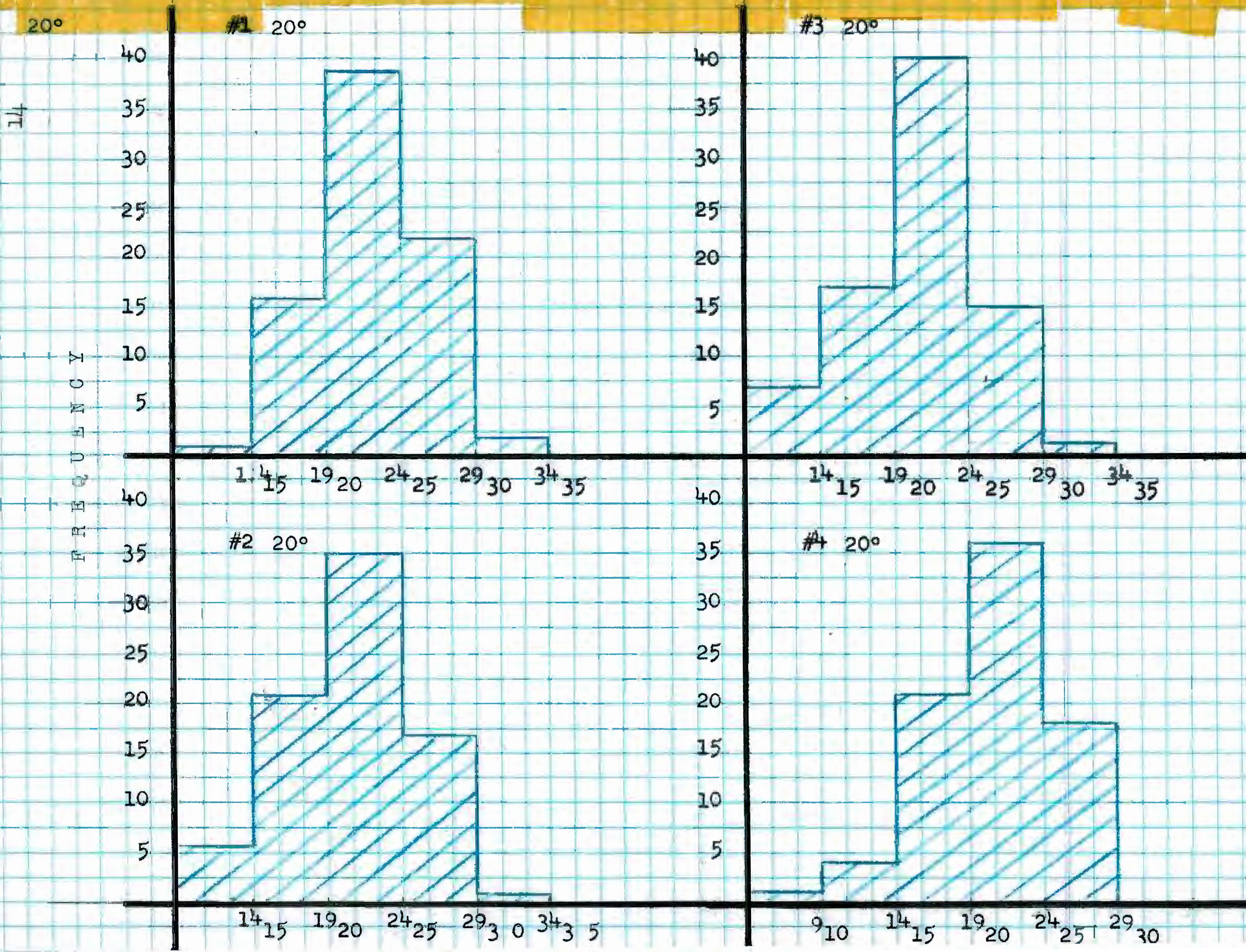
In the upper left hand corner of each frequency distribution graph is a number which corresponds to the position as found on page 6 from which the readings are taken and grouped.

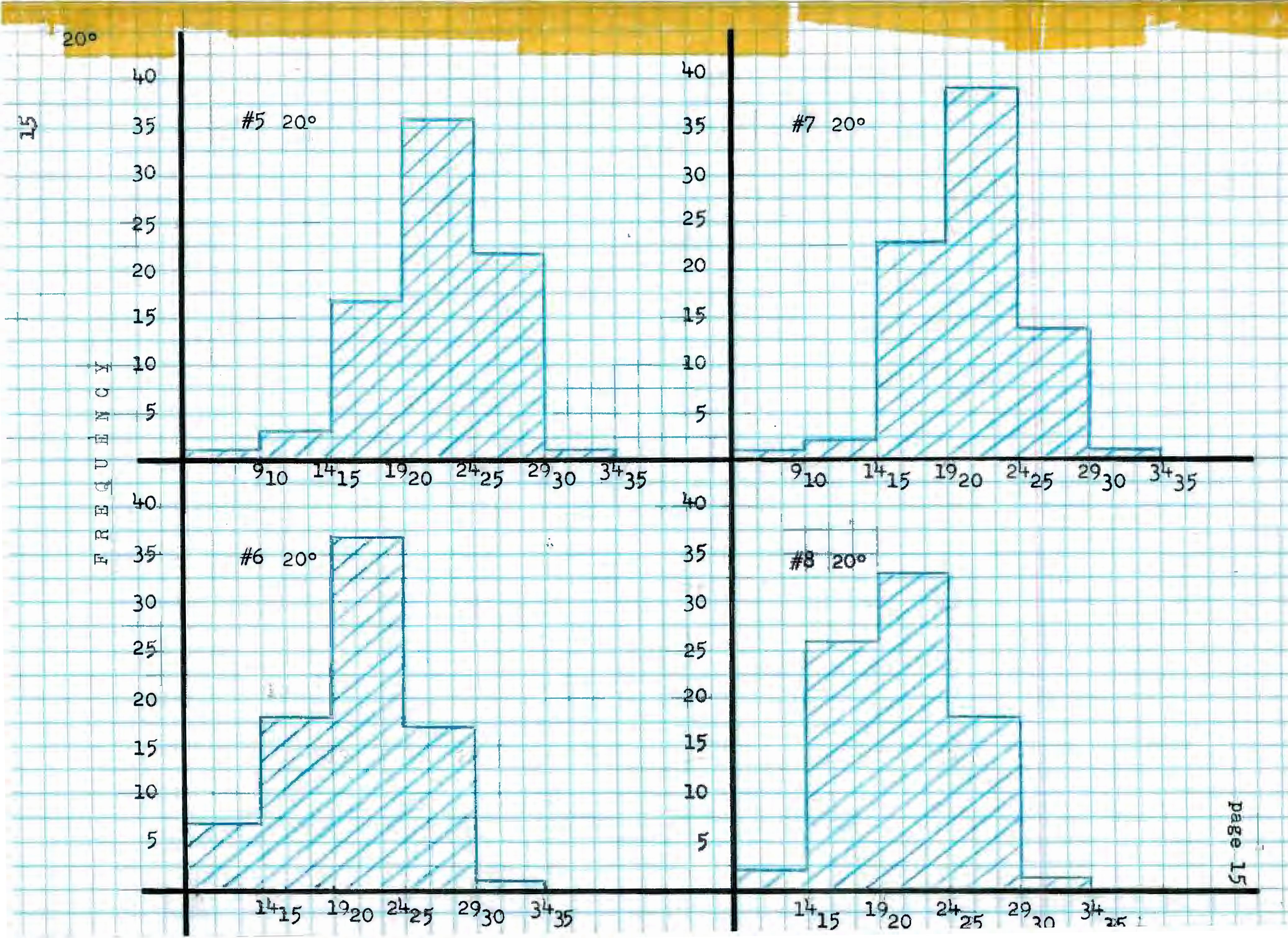
e.g. ---  #1 represents graphical distribution for readings from the 30° circle, area #1 for left and right eye visual fields. All graphs for the P.B.S. and central fixation do not have a number code but rather their exact positions are indicated by name.

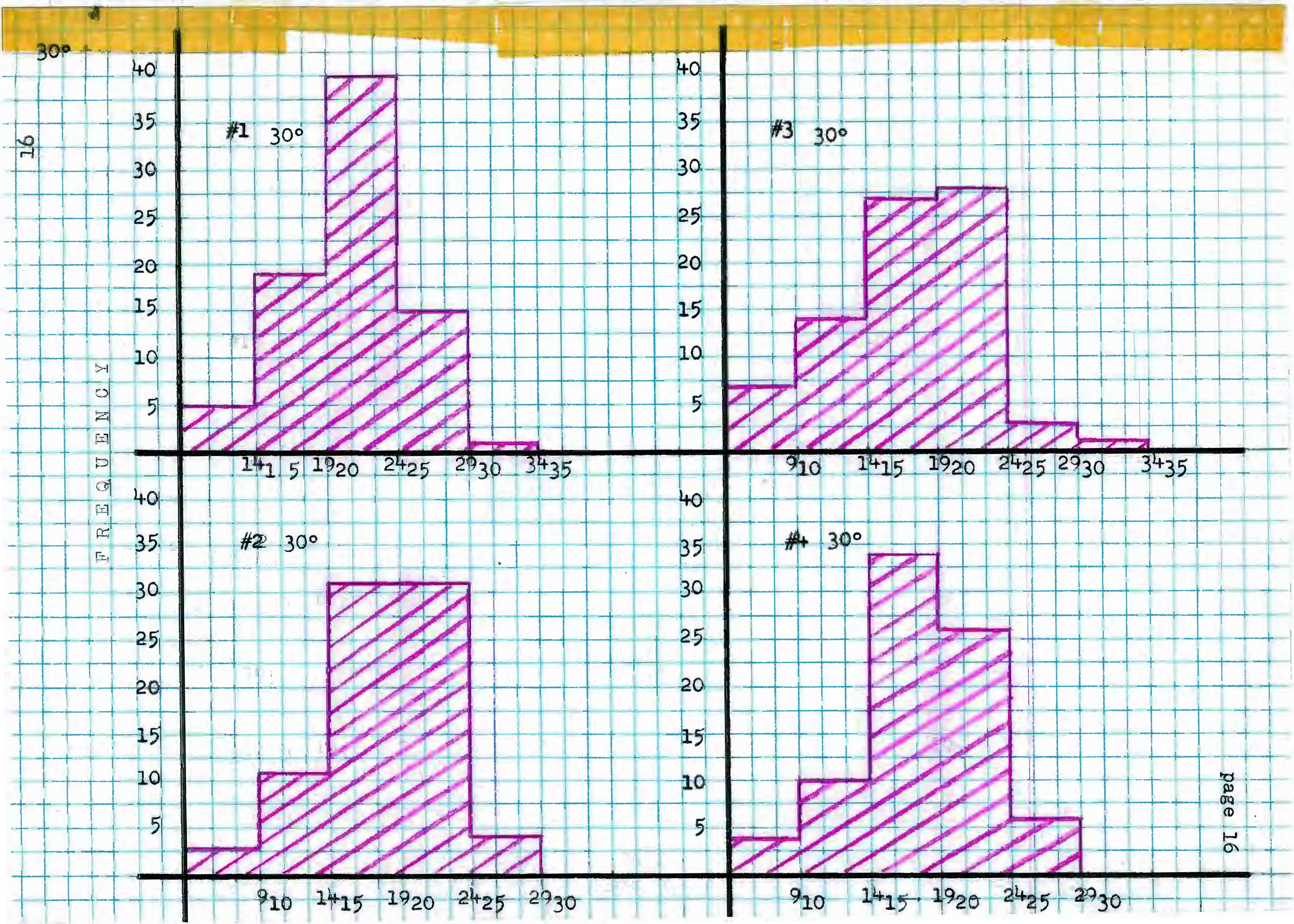

10°
#1 10°
#3 10°
#2 10°
#4 10°
FREQUENCY
40
35
30
25
20
15
10
5
14 15
19 20
24 25
29 30
34 35

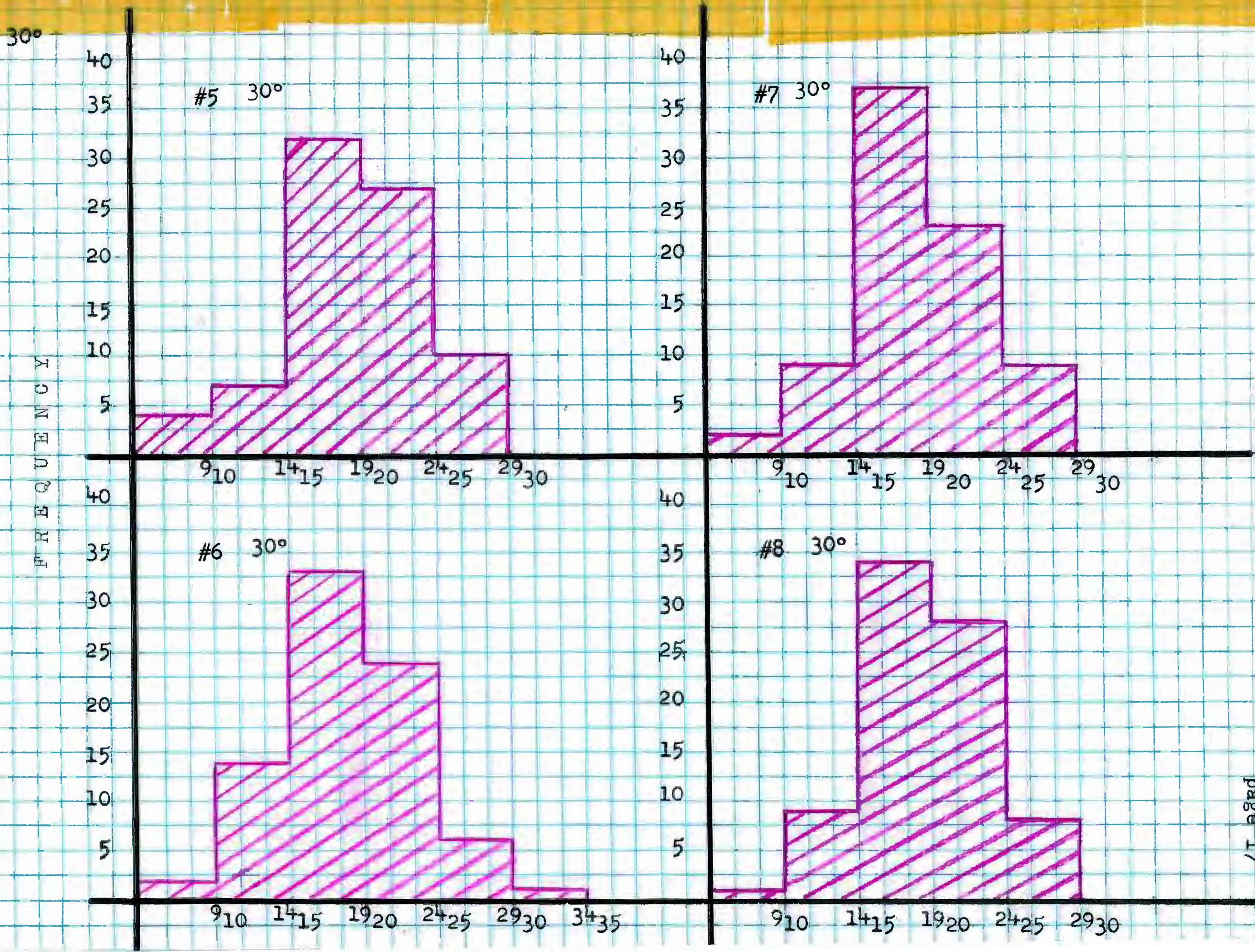


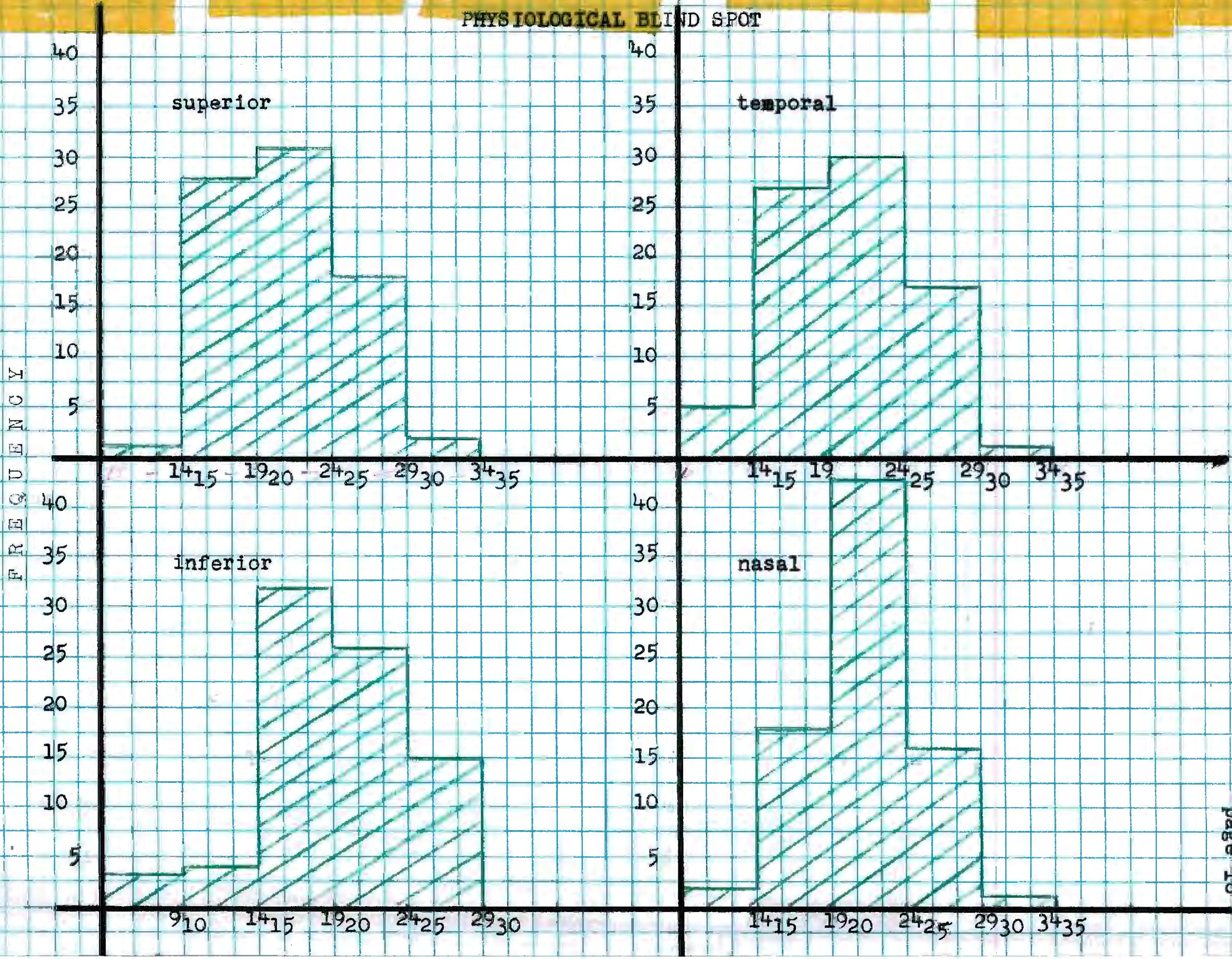
13
10°
#5 10°
#6 10°
#7 10°
#8 10°
FREQUENCY
40
35
30
25
20
15
10
5
14 15
19 20
24 25
29 30
34 35
page 1

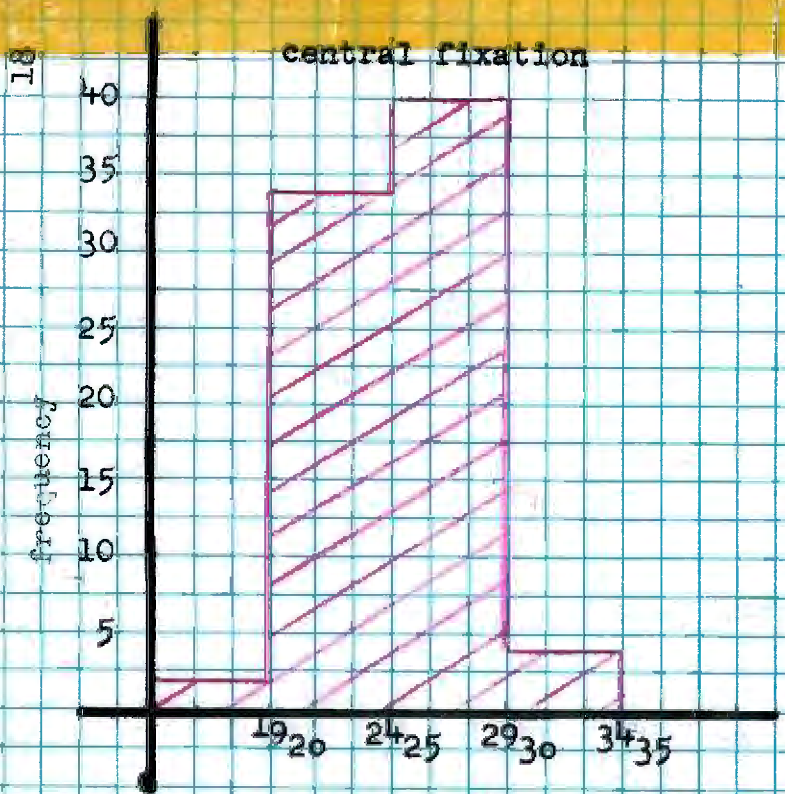

20°
#1 20°
#2 20°
#3 20°
#4 20°
FREQUENCY
40
35
30
25
20
15
10
5
14 15
19 20
24 25
29 30
34 35
9 10


20°
FREQUENCY
#5 20°
#7 20°
#6 20°
#8 20°
40
35
30
25
20
15
10
5
9 10
14 15
19 20
24 25
29 30
34 35


30°
FREQUENCY
#1 30°
#2 30°
#3 30°
#4 30°
40
35
30
25
20
15
10
5
14 15
19 20
24 25
29 30
34 35
9 10


30°
FREQUENCY
#5 30°
#6 30°
#7 30°
#8 30°
40
35
30
25
20
15
10
5
9 10
14 15
19 20
24 25
29 30
34 35


PHYSIOLOGICAL BLIND SPOT
FREQUENCY
superior
temporal
inferior
nasal
40
35
30
25
20
15
10
5
14 15
19 20
24 25
29 30
34 35
9 10


18
central fixation
frequency
40
35
30
25
20
15
10
5
19 20
24 25
29 30
34 35

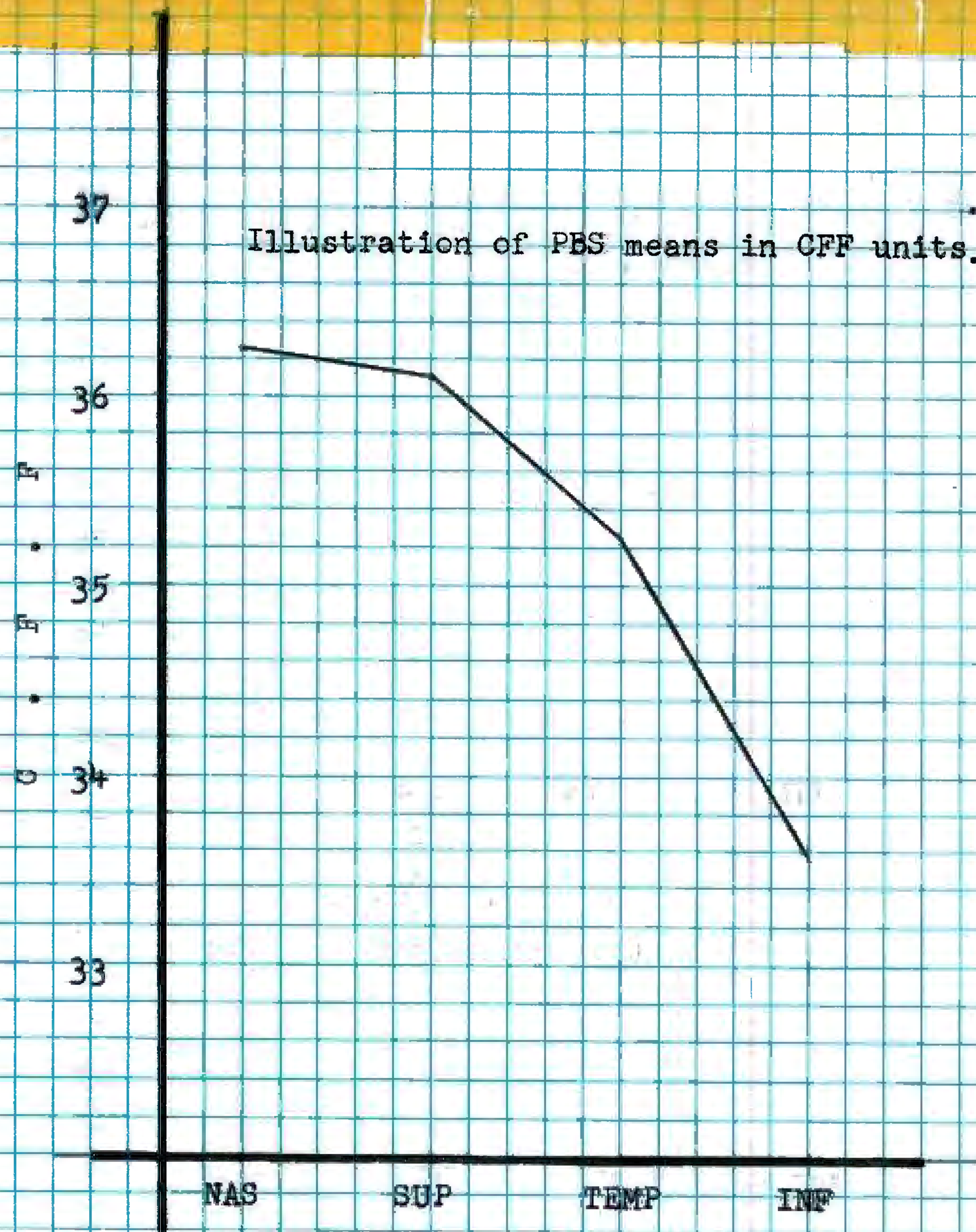


Illustration of PBS means in CFF units.
C. F. F.
37
36
35
34
33
NAS
SUP
TEMP
INF

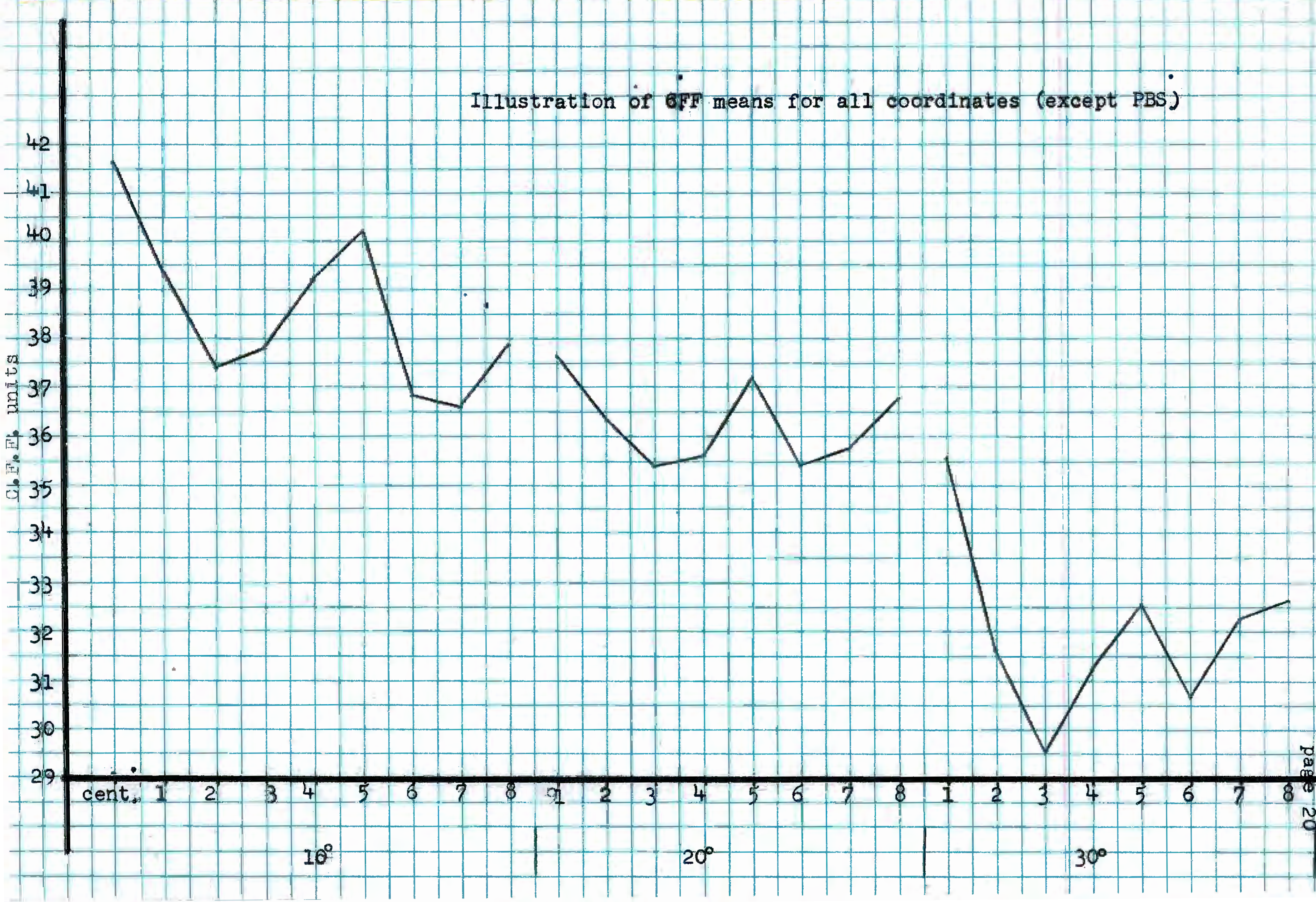


Illustration of CFF means for all coordinates (except PBS)
C.F.F. units
42
41
40
39
38
37
36
35
34
33
32
31
30
29
cent. 1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8
10°
20°
30°

CONCLUSION

Since there has been relatively little work done on this particular phase of visual fields analysis, it cannot be said that our compiled norms are not subject to further re-examination.

Inspection of the obtained values show the greatest sensitivity to flicker at the central fixation point, followed by decreasing sensitivity at each of the 10, 20, and 30 degree intervals respectively. The lowest sensitivity area is found at the superior 30 degrees visual field. The physiological blind spot shows the highest to lowest sensitivity in the order of nasal, superior, temporal and inferior positions.

RECOMMENDATIONS.

In various instances throughout the study a few of the subjects commented that they were influenced or able to hear the sound of the flicker sooner than it was visually perceived.

It is recommended that further consideration or study be given to the following, insofar as they may influence the obtained norms: pupil size, refractive error, defects of the media, low peripheral acuity, old age, dominant eye, size of the wand disc and comparison of "flicker to constant" with "constant to flicker".

Until more data is accumulated, the diagnostic import of flicker fusion frequency must depend upon precise adherence to the technique indicated.

It has been our experience that careful regulation of the "strobotac" dial with accurate readings thereof and recorded as well as precise placement of the wand cannot all be accomplished by the same clinician. It seems evident then, that if some method of "wand placement" and its maneuverability could be accomplished without the assistance of a second clinician that perhaps it would be worthy of consideration of being incorporated into the Optometrist's routine examination. Even with practice, a good flicker fusion frequency field still seems to require about the same care and length of time as the examination with standard methods of perimetry.

BIBLIOGRAPHY

REFERENCES

1. Phillips, G.: Perception of flicker in lesions of visual pathways, Brain 56: 464, 1933

2. Ibid.,

3. Riddell, L. A.: The use of the flicker phenomenon in the investigation of the field of vision., British Journal of Ophthalmology, 20:385 - 410 (July) 1936

4. Weekers, R. and Roussel, F.: Measured and clinical importance of apparent persistence of visual sense. Bull. d. Soc. Belg. d'ophthal. 83:27 - 36 1946 Ophthalmologica, 110:242, 1945; 112:395, 1946 115:297, 1948

5. Mayer, L.L. and Sherman, I. C.: A method of flicker perimetry. American Journal of Ophthalmology, 21:390 (April) 1938

6. Miles, P. W.: Flicker fusion frequency in amblyopia ex anopsia. American Journal of Ophthalmology 32:223 (June) 1949, Miles, P. W. Flicker fusion fields, American Journal of Ophthalmology 33:769 - 772 (May) 1950

7. Miles, P. W. Flicker fusion frequency in amblyopia ex anopsia, American Journal of Ophthalmology, 32:225 (June) Part II 1949

8. Ibid.,

9. Ibid.,

10. Ibid.,

11. Ibid.,

12. Miles, P. W., Flicker fusion fields: I The effect of age and pupil size. American Journal of Ophthalmology 33:769 (May) 1950

13. Miles P. W. Flicker fusion fields II: Technique and interpretation. American Journal of Ophthalmology 33:1069 (July) 1950

14. Tyler, D. B.: The fatigue of prolongued wakefulness. Federation Proc., 6:218 (March) 1947

15. Lythgoe, R. J. and Tansley, K.: The adaptation of the eye: Its relation to the critical fusion frequency. London, Spec. Report Ser. Med. Res. Council, No. 134, 1929

16. Brozek, J. and Keys, A.: Journal of Industrial Hygiene & Toxicology, 26:169 (May) 1944

17. Riddell, op. cit., 385 - 410

18. Meyer, & Sherman, op. cit., 390

19. Werner, H.: Critical fusion frequency in children with brain injury. American Journal of Psychology 45:394, 1942

20. Enzer, N., Simonson, E. et al.: Journal of Laboratory & Clincical Medicine, 29:63 (January) 1944; Ann. Int. Med., 16:701, 1942

21. Weekers, R., and Roussel, F.,: Measurement and Clinical Importance of Apparent Persistence of Visual Sense, Bull. d. Soc. Belg. d' Opht., 83:27 - 36 1946, Bull Soc. Franc. d' Ophth., 60:331 - 337, 1947: Ophthalmologia, 110:242, 1945; 112:305, 1946; 115:297, 1948