

## REPORT ON OBSERVATIONS MADE OF LIGHTS IN THE UNITED KINGDOM.

— 306 —  
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*(Translation from the Dutch text).*

THE Bureau has received a number of observations made of the lights of the United Kingdom during the period 1st August 1920 to 31st July 1922.

Although the number of observations made during two years only is insufficient for the deduction of definite conclusions as to the visibility of lights at various distances and, under unfavourable conditions, it would not even be sufficient to give an average idea of that visibility, yet part of the observations have been collated because they were made under specially favourable circumstances.

These circumstances are :

1. — the form and nature of the coasts of the British Isles, which are for the greater part high, with some deep inlets and numerous off-lying islands,
2. — the great number of lights on these coasts and in the islands, and
3. — the numerous lightships, some of which are stationed at a considerable distance from the shore.

These circumstances permit a light to be observed from several observation points at various distances and on different bearings, and thus curves can be drawn, for a certain number of lights, which give a satisfactory approximation of their visibility.

However, these are not the only circumstances which contribute to obtaining better results than on other coasts, they are due likewise to the fact that the visual ray between the observer and the observed light passes, as a rule, over the sea. So, as far as the lightships, the lower coasts and the islands are concerned, the observations have

been made under the same conditions as the seaman makes them, and they are trustworthy for they are free from the influence of the ascending heated air above sun-heated shores and sand dunes or of the vaporous emanations of swamps and pools, which sensibly affect the visibility of a light.

As to the observations made from high land and islands, the disadvantage of the adopted system of observing, *viç* : that the height of the observer is not taken into account, is felt to its full extent. It is incontestably true that this disadvantage is considerable for an observer at a great altitude observing a similarly elevated light, not only on account of the exaggerated percentage of visibility which results from such observations at comparatively short distances, but still more on account of the different layers of air through which the visual rays of a low and of a high observer pass. For example in regions where low fogs are frequent, the percentages of visibility of a high light observed from another high light will not take this state of the atmosphere into account.

An example of this difference is given by the curve of Bull Point (1604\*) in the Bristol Channel, *diagram* I. The percentage of visibility at a distance of about 18 miles to the West of this light is well established by the agreement of the observations from Lundy North and South, but Scarweather lightvessel, at about the same distance in a NE<sup>ly</sup> direction, from which Bull Point is at the limit of visibility, gives 28% less. Helwick lightvessel, from which Bull Point is 2.5 miles beyond the limit of visibility, nevertheless sees that light in 20 cases out of 100, which percentage represents that of very clear weather. Deducting these last from the percentages of Lundy North and South and of Scarweather, the remainder for the lightship is 16% only, while that for the shore station is 44% which means that, in general weather conditions, the sightings from the shore are nearly three times as numerous as those from the lightship.

Now, can this low percentage be explained by Bull Point light being at the limit of visibility of the lightvessel or is it caused by the SW<sup>ly</sup> direction in which she sees the shore light ?

The fact that Lundy North and South are seen by Helwick lightvessel, stationed to the NE of these lights 2 and 3.5 miles further than the limit of her visibility, in 32 and 18 cases out of 100 (*diagrams* 2 and 3), seems to indicate that the distance of Scarweather lightvessel from Bull Point is not the reason for the low percentage.

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\* Number in Light list 1923.

The light on Caldy Island, the only shore observation point which sees Bull Point light in a S<sup>ly</sup> direction, has a height of 214 feet while the observers on board the lightships stand at about 20 feet only above the water. So it appears very probable that the fog, the more tenacious moist haze accompanying W<sup>ly</sup> winds, and the thick weather mentioned in the West Coast of England Pilot, 6th edition 1910, pages 25 and 26, prevail in the lower layers of the atmosphere mainly. The number of hours during which the fog signals are in operation, at the stations mentioned, reaches a maximum of 1300 a year for Helwick lightvessel and is 501 only for Caldy Island. It is certainly necessary, both for the safety of shipping and also of the lightvessels themselves that the signals should be in operation early and late when fog prevails, but does this suffice to explain this very great difference of working hours ?

The fact that the percentages of visibility of the lights of Caldy Island, Mumbles, Nash Point and Lynmouth Foreland (situated respectively in directions North of West, ENE, NNW and SE<sup>ly</sup> of the lightvessels), as deduced from the observations of Scarweather and Helwick lightships, agree satisfactorily with the shore observations, tends to confirm the supposition of low fogs coming in from seaward.

On the other hand, the method applied enables a light to be observed at a greater distance than its geographic range, whereby the curve becomes more trustworthy and allows more exact percentages to be given for the seaman standing on a high bridge.

Owing to the proximity of the French coast the keepers of some French lights were able to make observations of a certain number of British lights in the Channel Islands and on the SE coast of England, and the Director of the Service des Phares at Paris has kindly provided the Bureau with the results of these observations.

Part of the observations can be verified, to a certain extent, by comparing the percentages which are computed for the mutual visibility of two lights. At short distances, and for lights whose luminous powers are approximately equal, these percentages should be nearly the same while, for the greater distances, they should increase from the low to the high power lights and the converse. Taking into account the comparatively short period during which observations were taken, very close agreement of these percentages cannot be expected and due allowance must be made for this.

The result of these mutual observations for 123 sets of shore lights and 26 sets of lightships is given in Appendix I, and in 6 cases only is there any notable discrepancy between the reciprocal percentages.

The allowance before mentioned should be made for all the following information also, with the exception of that as to the character of the curves of very high and very low powered lights, which may be said to be fairly well established.

The 84 shore lights chosen for the collation of the observations are, with the exception of 3, those observed from at least three observation stations. Some have been observed from 7 and South Foreland from no less than 9 points (*see* Appendix 2). Taking into account the curves of these series of lights of nearly equal candle power, the curves of the three lights mentioned could be drawn with some approach to accuracy and the percentage at the range of visibility could be ascertained fairly closely.

The lights are nearly all intended for making the coast and their names are printed in thick (**Ionic**) letters, as is done in the light list. The names of ten which are of minor importance are in Roman type and those of lightships in *italics*.

By adding the figures in columns 5 and 9, it may be ascertained whether a light is situated near the extreme of the range of vision of an observation station; the small percentages resulting from such observations are shown also, though it is evident that these will not be altogether reliable. Yet these percentages may be useful, because the knowledge of the maximum distance at which a luminous source itself, and not its glare, is seen under favourable conditions contributes to the determination of its visibility. Besides, observations which are of small importance at present may become important in the future, when changes in the lighting of the coast are made.

The percentages at the range of visibility given are approximate values only, as the curves will not reach their definite forms until observations have been made for a period of years; however, the character of the most powerful coast-lights may be said now to have been defined.

They show long curves, which depart but little from straight lines, with a moderate fall as is shown in *diagram* 4, while *diagram* 5 shows the short, rapidly dropping curves of lights of low candle-power.

As yet no percentages of visibility at various distances can be given, except for the lightships off the SE coast of England, and the only datum which has been ascertained is the percentage at the range of visibility. This percentage will give, in most cases, a fair idea as to whether the light fulfils the requirements of shipping.

The curves for St. Catherine (274) and South Foreland (340), the most powerful coast-lights of the Channel, except the Lizard which



is discussed below, and that of May Island (725), the very powerful light at the entrance of the Firth of Forth, clearly indicate that these lights fulfil the requirements of shipping to their fullest extent. The fact that the distance at which South Foreland is seen, in 90 cases out of 100, is smaller than for the other lights is probably due to its great elevation.

The curves for Pladda (1134) at the entrance to the Firth of Clyde and for Bailey (1723) in Dublin Bay, which lights are of about one million candle-power, are given in *diagram 6*. These are quite satisfactory but the curve of Oigh Sgeir (1048) on the West coast of Scotland is insufficiently defined, although the percentage at its limit of visibility may be estimated approximately therefrom.

The decision as to what limit should be taken for the minimum percentage, at the range of visibility, of a light intended for making the coast should, of course, be left to the competent authorities for they are the best judges of the requirements of local shipping. However, attention should be called to a very few lights the percentage of visibility of which at that distance is rather small.

The elaboration of the observations of those lights which are not given in Appendix 2 will be taken in hand, but it will not be feasible to utilise the observations of the greater number of these lights, nor those observed from one station only, until the coefficients of transparency of the atmosphere for the different coasts of the United Kingdom have been ascertained and the law of Blondel-Rey has been proved to give trustworthy results. As it can be observed from Wolf Rock only and though observations therefrom were sent, it is much to be regretted that the very important light at the Lizard has had to be included in this category.

The observations of lightships from the shore and from other lightships are given in Appendix 2, classified according to their candle-power.

The number of observations for each of these is not sufficient to permit them to be elaborated separately, as has been done for the coast-lights; taking the candle-power into account this elaboration may be done in local groups. The most numerous group to deal with is undoubtedly that on the SE coast of England, where no less than 36 lightships are found between Dungeness and the Humber. It will be difficult to find, in any other part of the world, such splendid material as that which can be gathered here.

In Appendix 3 the results of the observations are given in a more concise form; the percentages, as established from shore observations,

are given in **heavy type**. These have not been taken into account in tracing *diagrams* 7 to 11 except Chapman, Maplin and Gunfleet which are at elevations of only 26 to 41 feet and therefore may be taken as giving practically similar results as do observations from lightship to lightship. Yet these shore observations are very useful for checking those of the lightships whenever doubt arises.

In the diagrams the number of observations at the same distance, the mean value of which has been taken, is entered close to the point which defines the curve; the higher this number the more weight has been given to the point in tracing the curve.

Appendices 2 and 3 show that, up to distances of about 7 miles, the shore observations give results which agree approximately with lightship observations. At distances greater than about 7 miles, the percentages from the shore are, as a rule, greater than those of the lightships though the 25 % of *Varne*, observed from Dover Pier at 10.6 miles; the 62 % of *Goodwin*, observed from S. Foreland at 9.6 miles; and the 43 % of *Cockle*, observed from Haisborough at 11.7 miles, agree fairly well with the curves. On the other hand the 49 % of *Cork*, observed from Gunfleet at 10.4 miles, is too high; this percentage approaches that of lightships with a luminous power of 12 to 35,000 candles at the distance.

The last diagram and the following table deduced from it :

Candle-power	Distances in nautical miles										
	1	2	3	4	5	6	7	8	9	10	11
2 to 5.000	99 <sup>o</sup> / <sub>o</sub>	96 <sup>o</sup> / <sub>o</sub>	93 <sup>o</sup> / <sub>o</sub>	90 <sup>o</sup> / <sub>o</sub>	86 <sup>o</sup> / <sub>o</sub>	80 <sup>o</sup> / <sub>o</sub>	72 <sup>o</sup> / <sub>o</sub>	60 <sup>o</sup> / <sub>o</sub>	45 <sup>o</sup> / <sub>o</sub>	32 <sup>o</sup> / <sub>o</sub>	18 <sup>o</sup> / <sub>o</sub>
8.000	99	98	95	92	89	84	77	67	52	40	27
12 to 35.000	99	98	97	94	90	85	77	70	63	56	49
140.000 & upwards	99	99	98	96	93	90	85	78	71	64	57

show that, at the same distance, the curves give percentages which increase with the candle-power. Some allowance should be made for these figures on account of the small number of years during which observations were made, the lack of regularity in this increase is undoubtedly due to this cause.

As the various lightships have been moored in their stations with different objects in view, candle-powers varying within wide limits have been given to their lights. Thus the low-power light of Calshot

Spit lightship, in Southampton Water, has a task to fulfil which is absolutely different from that of the very powerful one of Kentish Knock, in the approaches to the Thames, and the competent authorities should therefore decide whether the percentages of visibility at various distances, as derived from the curves, fulfil the requirements of shipping.

The preceding table brings out clearly the considerable increase of candle-power which must be given to the light of a lightship to make it visible more frequently at the same distance or with the same frequency at a greater distance. Should this be required, another generating source of considerably higher luminous power seems to be indicated rather than an increase in the candle-power of the same source.

Lightships in the Channel are not numerous and the small number of surrounding observation points are nearly all on shore and at considerable elevation.

As is shown in the following table

	Channel				SE. coast of England.				
	8			12	8		9	8	
Candle power in 1000 candles . . . . .									
Distance in miles. . . . .	4.5	5.5	15	7.6	4.6	5.6	1.59	6.7	8.2
Height of observer in feet . . . . .	141	71	149	103	41	70	113	188	93
Percentage . . . . .	94	93	49	78	92	91	24	69	70

the percentages up to about 6 miles, except for the very low-power light of Calshot Spit, are about the same as for the SE coast of England ; for greater distances the percentages of visibility in the Channel are greater.

Seven Stones is discussed with the lights of the West coast of England.

The height of the observer is shown in the table as it may have some influence on the percentage of visibility.

For the West coast of England and the S. and E. coasts of Ireland the observations taken from West Usk have been given the same value as those of a lightship on account of its low altitude, *viz* : 47 feet.

Compared to the SE. coast of England, the observations from lightship to lightship off this coast are very scarce. They are given in the next table, in which *Barrels Rock* observed from *Coningbeg*, at a distance of 10.5 miles, gives the very dubious result of 25 %.

	Candle-power in 1000 candles	Distance in nautical miles	Percentage	Percentage as deduced from diagr. of SE. coast of England
Lucifer. . . . .	8	10	33	40
Seven Stones. . . . .	12	11	79	49
		12.4	64	38
		12.8	56	35
		16.8	52	—
South Rock . . . . .	12	8.2	85	69
Arklow . . . . .	12	10	66	56
Blackwater. . . . .	20	10	75	56
Barrels. . . . .	28	10.5	25	52
Skulmartin. . . . .	28	8.2	88	69
Coningbeg. . . . .	70	10.5	75	60

Except for *Lucifer*, the percentages at the same distance are greater than those for the SE. coast of England. The shore observations have been collated in the same way as those in the Channel.

The observations of the lightships in the Irish Sea and its SW approach, compared to those of the SE coast of England, give the following results :

**Irish Sea and S.W. approach.**

Candle power in 1000 candles . . .	8							12							
	Distance in nautical miles . . . . .	9.3	13.3	13.6	14.5	14.9	18.3	5.4	5.6	6.7	7.2	7.8	10.8	11	12.4
Height of observer in feet . . . . .	108	197	220	184	336	154	134	47	164	164	53	140	180	110	110
Percentage . . . . .	65	58	47	44	43	34	94	82	83	83	83	70	79	64	56

**S.E. coast of England.**

Candle power in 1000 candles . . .	8			12		8	9	12	8		12		8		5	8	20	8
	Distance in nautical miles . . . . .	9.5	9.6	9.6	13	13.9	15	15.9	16.2	18	5.5	5.8	7	8.2	10.6	11	12.2	13
Height of observer in feet . . . . .	136	131	93	93	136	149	113	123	136	71	178	240	70	70	123	70	93	
Percentage . . . . .	63	61	56	30	40	49	24	43	21	93	85	70	93	25	55	48	30	

**Irish Sea and S.W. approach.**

Candle power in 1000 candles . . .	12				20				28				70			
	Distance in nautical miles . . . . .	16.8	18.4	19.3	11.2	12.3	14.2	14.5	19.5	4.9	9.1	10	12	12.2	11.3	19.5
Height of observer in feet . . . . .	195	121	220	159	214	214	177	108	98	108	121	236	195	152	108	
Percentage . . . . .	52	35	23	61	55	45	51	28	93	65	71	49	60	84	33	

**S.E. coast of England.**

Candle power in 1000 candles . . .	8		12		8		20		12		8		20		8		20		8	
	Distance in nautical miles . . . . .	16.2	18	19	11	11.6	12.3	13.9	15	20	4.5	8.4	9.6	10	11.7	12.2	11.6	20		
Height of observer in feet . . . . .	123	136	274	123	130	123	136	149	274	141	188	274	274	136	70	130	274			
Percentage . . . . .	43	21	18	55	32	45	40	49	8	94	71	62	52	43	48	32	8			

A comparison of the two areas shows that, out of 31 observations, 6 only are 0 to 10 % and on an average 4 % inferior to the percentages of the SE. coast of England; the others are 2 to 52 %, and on an average 15 % greater.

Judging by both the results for lightships it seems that, as a general rule, the transparency of the atmosphere in the Irish Sea and its Southern approaches is greater than that on the shores of the North Sea. However, this conclusion requires confirmation by comparing the curves of shore lights of the same candle-power as soon as the observations have been made during a sufficient period for them to be considered as being definitely established.



# APPENDIX I.

## I. MUTUAL VISIBILITY OF LIGHTHOUSES.

No in light-list 1923 of light A	NAME OF LIGHT A	Candle power in 1000 of light A	Percentage of visibility of B from A	Distance between A and B in nautical miles	Percentage of visibility of A from B	Candle power in 1000 of light B	NAME OF LIGHT B	No in light-list 1923 of light B	REMARKS
1	2	3	4	5	6	7	8	9	10
1	Bishop Rock . . . . .	622	89	7.8	94	415	Round Island . . . . .	6	
	id. . . . .		29	25.2	54	70	Wolf Rock . . . . .	11	
6	Round Island . . . . .	415	47	27.8	45	190	Pendeen . . . . .	1627	
	id. . . . .		60	20.4	58	70	Wolf Rock . . . . .	11	
10	Longships. . . . .	35	90	7.7	92		id. . . . .		
22	Lizard . . . . .		43	23.6	71		id. . . . .		
122	Portland Bill . . . . .	256	61	19.5	57	145	Anvil Point . . . . .	177	
141	Caskets . . . . .	184	96	8.3	95	400	Alderney . . . . .	142	
	id. . . . .		56	17.2	71	92	Serk . . . . .	147	
142	Alderney . . . . .	400	59	18.8	71		id. . . . .		
159	Hanois . . . . .	74	62	21.4	45	184	Caskets . . . . .	141	
177	Anvil Point . . . . .	145	68	14.7	69	35	Needles . . . . .	192	
	id. . . . .		58	25.2	36	very powerful	St. Catherine . . . . .	274	
192	Needles . . . . .	35	86	12.2	65		id. . . . .		
197	Hurst. . . . .	31	97	3	83	35	Needles . . . . .	192	
313	Dungeness . . . . .	164	53	18	52	100	Dover pier . . . . .	323	
	id. . . . .		53	20.2	49	very powerful	South Foreland . . . . .	340	
323	Dover pier . . . . .	100	98	2.4	93		id. . . . .		
355	North Foreland . . . . .	35	67	14.2	51		id. . . . .		
454	Southwold . . . . .	35	61	14.8	27	315	Ordfordness. . . . .	452	
604	Souter Point . . . . .	23	72	6.8	68	374	St. Mary . . . . .	613	
	id. . . . .		11	22.6	18	35	Coquet . . . . .	621	
613	St. Mary . . . . .	374	34	16	46		id. . . . .		
634	Longstone . . . . .	206	37	18.8	55		id. . . . .		
	id. . . . .		48	24.4	55	173	St. Abbs Head. . . . .	639	
639	St. Abbs Head. . . . .	173	84	11.1	84	565	Barns Ness. . . . .	640	
	id. . . . .		61	19.3	65	156	Bass Rock. . . . .	644	
	id. . . . .		62	21.5	53	very powerful	Isle of May . . . . .	725	
640	Barns Ness. . . . .	565	81	12.7	75		id. . . . .		
	id. . . . .		88	8.6	90	156	Bass Rock. . . . .	644	
646	Fidra Island. . . . .	1¼	94	4.8	92		id. . . . .		
660	Inchkeith . . . . .	167	54	16.8	62		id. . . . .		
	id. . . . .		42	12	71	1¼	Fidra Island . . . . .	646	
725	Isle of May . . . . .	very powerful	55	10.2	82		id. . . . .		
	id. . . . .		44	21.3	48	167	Inchkeith . . . . .	660	
	id. . . . .		59	16	66	392	Bell Rock . . . . .	729	
769	Scurdy Ness. . . . .	23	68	16.2	54		id. . . . .		
783	Tod Head . . . . .	280	8	27.7	7		id. . . . .		

No in light- list 1923 of light A	NAME OF LIGHT A	Candle power in 1000 of light A	Perce- tage of visibi- lity of B from A	Distan- ce between A and B in nautical miles	Perce- tage of visibi- lity of A from B	Candle power in 1000 of light B	NAME OF LIGHT B	No in light- list 1923 of light B	REMARKS
1	2	3	4	5	6	7	8	9	10
875	Noss Head. . . . .	93	52	28	54	180	Copinsay . . . . .	924	
	id. . . . .		75	13.4	79	29	Pentland Skerries . . . . .	891	
891	Pentland Skerries . . . . .	29	81	14	71	141	Dunnet Head . . . . .	896	
	id. . . . .		80	14.9	77	180	Copinsay . . . . .	924	
	id. . . . .		56	23.3	46	32	Auskerry . . . . .	925	
895	Stroma . . . . .	156	96	6	98	29	Pentland Skerries . . . . .	891	
	id. . . . .		93	8.2	92	141	Dunnet Head . . . . .	896	
897	Holburn . . . . .	15	93	5.8	93		id. . . . .		
924	Copinsay . . . . .	180	92	8.4	90	32	Auskerry . . . . .	925	
934	Start Point . . . . .	12½	66	15.9	36	32	id. . . . .		
	id. . . . .		92	6.5	76	80	North Ronaldsay. . . . .	937	
941	Noup Head . . . . .	336	57	21.4	57	80	id. . . . .		Visual ray passes over Westray & Papa Westray.
942	Scaddon . . . . .	141	46	24.4	49		id. . . . .		
986	Ru Stoer . . . . .	27	56	26.2	38	295	Rudh' Rè . . . . .	989	
990	Rona . . . . .	6	80	17.2	67		id. . . . .		
1012	Butt of Lewis . . . . .	484	1	32	18	27	Ru Stoer . . . . .	986	
1015	Tiumpán Head . . . . .	480	42	23.1	65		id. . . . .		
	id. . . . .		37	26.5	49	295	Rudh' Rè . . . . .	989	
1021	Glas Island . . . . .	350	15	26.8	32		id. . . . .		Ru Stoer at 26.2 miles gives 56% Tiumpánhead at 26.5 miles 15.
1027	Ushinish . . . . .	61	42	25.9	35	1000	Oigh Sgeir . . . . .	1048	
1042	Barra Head . . . . .	39	33	33.7	24		id. . . . .		
1049	Skerryvore . . . . .	186	66	19.6	57	480	Dubh Artach . . . . .	1050	
1050	Dubh Artach . . . . .	480	21	27.7	24	233	Rhinns of Islay . . . . .	1110	
1056	Ardnámurchan . . . . .	39	55	20.6	54	1000	Oigh Sgeir . . . . .	1048	
1102	Rudha Mairi . . . . .	11	66	20.7	6	480	Dubh Artach . . . . .	1050	
1104	Mac Arthur Head . . . . .	13	49	28.5	31	281	Mull of Cantyre . . . . .	1116	
1116	Mull of Cantyre . . . . .	281	25	32.8	32	233	Rhinns of Islay . . . . .	1110	
	id. . . . .		59	23	63	270	Maidens. . . . .	1770	
	id. . . . .		80	13	85	230	Rathlin East . . . . .	1777	
1117	Sanda . . . . .	61	64	20.5	65		id. . . . .		
	id. . . . .		55	21.7	55	95	Corsewall . . . . .	1232	
	id. . . . .		61	21.5	62	270	Maidens. . . . .	1770	
	id. . . . .		20	29	14	840	Killantringan . . . . .	1235	
1118	Davazr . . . . .	3	75	14.5	47	1000	Pladda . . . . .	1134	
1134	Pladda . . . . .	1000	77	10.5	84	40	Ailsa Craig . . . . .	1223	
	id. . . . .		62	11.3	84	6	Turnberry . . . . .	1224	
	id. . . . .		19	25.2	34	95	Corsewall . . . . .	1232	
1136	Holy Island . . . . .	392	66	16	71	40	Ailsa Craig . . . . .	1223	
1223	Ailsa Craig . . . . .	40	71	14.8	73	95	Corsewall . . . . .	1232	
	id. . . . .		74	10	85	6	Turnberry . . . . .	1224	



No in light-list 1923 of light A	NAME OF LIGHT A	Candle power in 1000 of light A	Percentage of visibility of B from A	Distance between A and B in nautical miles	Percentage of visibility of A from B	Candle power in 1000 of light B	NAME OF LIGHT B	No in light-list 1923 of light B	REMARKS	
1	2	3	4	5	6	7	8	9	10	
1232	Corsewall . . . . .	95	18	22	42	6	Turnberry . . . . .	1224	Sanda and Turnberry, both 21.7 miles distant from Corsewall, give no more than 55 % & 42 %.	
	id. . . . .		58	25.3	67	165	Black Head . . . . .	1765		
	id. . . . .		62	20.5	65	270	Maidens. . . . .	1770		
1235	Killantringan . . . . .	840	62	20.8	69	165	Black Head . . . . .	1765		
1237	Mull of Galloway . . . . .	29	35	30.4	55	165	id.	Percentage from Blackhead appears to be to great.		
	id. . . . .		48	21.8	53	66	Aire Point . . . . .			1280
1240	Little Ross . . . . .	69	44	23.5	46	35	id.	St. Bees . . . . .		1279
	id. . . . .		45	22	45	35	St. Bees . . . . .			1279
1280	Ayre Point . . . . .	66	40	26.5	43		id.	Little Ross . . . . .		1240
1302	Maughold Head . . . . .	569	33	29.2	42	69	Little Ross . . . . .			1240
	id. . . . .		45	27.1	44	35	St. Bees. . . . .	1279	South Stack. . . . .	1442
1426	Skerries . . . . .	274	94	7.7	93	274	South Stack. . . . .	1442		
1466	Strumble Head . . . . .	400	63	16.5	75	129	South Bishop . . . . .	1467	Smalls . . . . .	1468
1467	South Bishop . . . . .	129	84	12.4	78	44	Smalls . . . . .	1468		
	id. . . . .		73	10.5	82	11	Skokham . . . . .	1469	id.	1470
1468	Smalls . . . . .	44	62	14.5	78		id.			
	id. . . . .		61	18.8	67	35	St. Anne . . . . .	1470	id.	1608
1469	Skokham . . . . .	11	97	4.3	96		id.			
1489	Caldy Island . . . . .	35	44	25.7	37	374	Lundy North . . . . .	1608	Lundy South . . . . .	1609
	id. . . . .		37	28	30	206	Lundy South . . . . .	1609		
1524	Nash Point . . . . .	35	83	12.6	81	190	Lynmouth Foreland . . . . .	1598	Bull Point . . . . .	1604
	id. . . . .		28	27.4	40	182	Bull Point . . . . .	1604		
1534	Flatholm . . . . .	35	79	8.9	81	10	Burnham . . . . .	1591	Lynmouth Foreland . . . . .	1598
	id. . . . .		49	26.7	24	190	Lynmouth Foreland . . . . .	1598		
1544	West Usk . . . . .	12	64	11	64	35	Flatholm . . . . .	1534	Lundy South . . . . .	1609
1606	Bideford . . . . .	31	64	18.1	43	206	Lundy South . . . . .	1609		
1608	Lundy North . . . . .	374	67	18.1	71	182	Bull Point . . . . .	1604	Lynmouth Foreland . . . . .	1598
1609	Lundy South . . . . .	206	5	33.6	7	190	Lynmouth Foreland . . . . .	1598		
	id. . . . .		67	17.6	71	182	Bull Point . . . . .	1604	Lundy South . . . . .	1609
1613	Hartland Point . . . . .	115	91	9.7	87	206	Lundy South . . . . .	1609		
1616	Trevoise. . . . .	248	5	34	4	190	Pendeen . . . . .	1627	2 miles within maximum distance of visibility.	
1638	Old Head of Kinsale. . . . .	460	48	24.3	62	160	Ballycotton . . . . .	1669		
1703	Wicklow Head. . . . .	120	65	23.7	45	950	Bailey . . . . .	1723		
1712	Kingstown East Pier. . . . .	67	98	4.4	96		id.			

## MUTUAL VISIBILITY OF LIGHTHOUSES.

No in light- list 1923 of light A	NAME OF LIGHT A	Candle power in 1000 of light A	Percen- tage of visibi- lity of B from A	Distan- ce between A and B in nautical miles	Percen- tage of visibi- lity of A from B	Candle power in 1000 of light B	NAME OF LIGHT B	No in light- list 1923 of light B	REMARKS
1	2	3	4	5	6	7	8	9	10
1754	Mew Island . . . . .	177	93	7.5	96	165	Black Head . . . . .	1765	
	id. . . . .		81	15.7	74	270	Maidens. . . . .	1770	
1767	Farres Point . . . . .	2	99	5.3	90		id. . . . .		
1777	Rathlin East . . . . .	230	51	27.3	53		id. . . . .		
1778	Rathlin West . . . . .	250	13	33.3	4	200	Inishtrahull. . . . .	1807	
1777	Rathlin East . . . . .	230	59	25.2	52	233	Rhinns of Islay . . . . .	1110	
1778	Rathlin West . . . . .	250	60	23.6	41		id. . . . .		Notwithstanding the considerable difference, both percentages agree with the other observa- tions.
1784	Inishowen. . . . .	8	37	22.5	35	250	Rathlin West . . . . .	1778	1 mile within maximum dis- tance of visibi- lity.
1807	Inistrahull . . . . .	200	46	28.2	39		Rhinns of Islay . . . . .	1110	
1808	Fanad Head. . . . .	57	89	16.3	56	200	Inishtrahull. . . . .	1807	

# APPENDIX I.

## II. MUTUAL VISIBILITY OF LIGHT-VESSELS.

N. B. — Lighthouses are *underlined*.

N <sup>o</sup> of light A in light-list 1923	NAME OF LIGHT A	Candle power of light A in 1000	Distance of horizon of light A in nautical miles	Percentage of visibility of A from B	Distance between A and B in nautical miles	Percentage of visibility of B from A	Distance of horizon of light B in nautical miles	Candle power of light B in 1000	NAME OF LIGHT B	N <sup>o</sup> of light B in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
344	South Goodwin. . . . .	8	4	86	6.8	78	4	8	Gull. . . . .	346
344	South Goodwin. . . . .	8	4	83	6.7	82	4	20	East Goodwin . . . . .	345
346	Gull. . . . .	8	4	84	5.7	89	4	20	East Goodwin . . . . .	345
346	Gull. . . . .	8	4	87	5.5	89	4	12	North Goodwin. . . . .	347
366	Girdler . . . . .	140	4	92	5.8	83	6	11	Maplin. . . . .	413
367	Edinburgh. . . . .	2.5	4	75	7.5	81	4	140	Girdler . . . . .	366
367	Edinburgh. . . . .	2.5	4	86	5.3	83	4	8	Tongue . . . . .	362
369	Nore. . . . .	2	4	79	6.1	79	4	35	Mouse . . . . .	411
411	Mouse. . . . .	35	4	85	5.5	82	6	R 4	Maplin. . . . .	413
415	Swin Middle . . . . .	25	4	95	3.9	88	6	R 4	Maplin. . . . .	413
415	Swin Middle . . . . .	25	4	45	11.4	22	7	R 80	Gunfleet . . . . .	417
416	Barrow Deep. . . . .	8	4	91	4.6	93	7	R 80	Gunfleet . . . . .	417
418	Sunk . . . . .	8	4	85	5.2	89	4	16	Longsand . . . . .	419
420	Kentish Knock . . . . .	180	4	75	8.4	75	4	16	Longsand . . . . .	419
450	Cork . . . . .	2	4	49	10.4	56	7	R 80	Gunfleet . . . . .	417
451	Shipwash . . . . .	8	4	16	11.4	22	4	8	Outer Gabbard . . . . .	453
469	St. Nicholas . . . . .	5	4	70	6.2	84	4	20	Cockle. . . . .	484
470	Cross Sand. . . . .	8	4	82	6.5	83	4	20	Cockle. . . . .	484
470	Cross Sand. . . . .	8	4	82	6.5	84	4	12	Newarp . . . . .	486
486	Newarp . . . . .	12	4	87	5.5	85	4	20	Cockle. . . . .	484
490	Would. . . . .	8	4	62	8.6	60	4	20	Cockle. . . . .	484
514	Dudgeon. . . . .	8	4	9	11.3	9	4	8	Cromer Knoll . . . . .	516
1692	Barrels . . . . .	28	4	23	10.6	75	4	70	Coningbeg. . . . .	1691
1697	Lucifer . . . . .	8	4	33	10	74	4	20	Blackwater. . . . .	1699
1700	Arklow . . . . .	12	4	66	9.9	77	4	20	Blackwater. . . . .	1699
1750	South Rock . . . . .	12	4	85	8.2	88	4	28	Skulmartin . . . . .	1751

# APPENDIX 2.

## I. OBSERVATIONS OF LIGHTHOUSES.

OBSERVED LIGHT						OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
2	<b>Penninis Head.</b> . . . .	110	100	16	60	92 63 55 8	5.8 13 19.5 29.2	13 4 12 16	Bishop Rock . . . . . Seven Stones . . . . . Wolf Rock . . . . . Pendeen . . . . .	1 7 11 1627
6	<b>Round Island.</b> . . . .	180	415	19	68	89 86 58 45	7.8 11 20.4 27.8	13 4 12 16	Bishop Rock . . . . . Seven Stones . . . . . Wolf Rock . . . . . Pendeen. . . . .	1 7 11 1627
10	<b>Longships</b> . . . . .	110	35	16	73	92 80 56	7.7 12.8 23.2	12 4 15	Wolf Rock . . . . . Seven Stones . . . . . Round Island. . . . .	11 7 6
11	<b>Wolf Rock.</b> . . . . .	110	70	16	70	90 79 60 43 29	7.7 12.4 20.4 23.6 25.2	12 4 15 17 13	Longships . . . . . Seven Stones . . . . . Round Island . . . . . Lizard. . . . . Bishop Rock . . . . .	10 7 6 22 1
141	<b>Casquets.</b> . . . . .	120	184	17	73	95 71 62 18	8.3 17.2 21.4 30.5	12 16 11	Alderney . . . . . Serk . . . . . Hanois. . . . . Carteret (Fr). . . . .	142 147 159
142	<b>Alderney.</b> . . . . .	121	400	17	76	97 96 71 57	8.2 8.3 18.8 25.5	12 16	Cap la Hague (Fr) . . . . . Caskets . . . . . Serk . . . . . Carteret (Fr). . . . .	141 147
147	<b>Serk</b> . . . . .	213	92	21	47	56 59 48 37	17.2 18.8 21.3 23	12 12	Caskets . . . . . Alderney . . . . . Carteret (Fr). . . . . Cap la Hague (Fr) . . . . .	141 142
176	<b>Corbière Rock.</b> . . . .	119	16 6*	17	prob- 55	28* 38 20	15.9 22.5 23.5	16 11	Serk . . . . . Roches Douvres (Fr). . . . . Hanois . . . . .	147 159
177	<b>Anvil Point.</b> . . . . .	149	145	18	61	69 77 59 61 36	14.7 15 16.9 19.5 25.2	10 4 10 13 13	Needles . . . . . Shambles. . . . . Hurst . . . . . Portland Bill. . . . . St. Catherine . . . . .	192 137 197 122 274
192	<b>Needles.</b> . . . . .	80	35	14	65	97 65 68	3 12.2 14.6	10 13 14	Hurst . . . . . St. Catherine . . . . . Anvil Point . . . . .	197 274 177

\* Red light.

OBSERVED LIGHT						OBSERVING LIGHTS										
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923						
1	2	3	4	5	6	7	8	9	10	11						
274	<b>St. Catherine.</b>	136		17	76	86	12.2	10	Needles	192						
						44	23.2	4	Owers	276						
						58	25	14	Anvil Point	177						
						4	44	13	Portland Bill	122						
						4	52.5		Barfleur (Fr)							
						4	53.2		Cap Levi (Fr)							
313	<b>Dungeness.</b>	130	164	17	60	81	11.6	4	Varne	316						
						52	18	9	Dover pier	323						
						49	20.2	22	South Foreland	340						
						30	23		Grisnez (Fr)							
						20	23	4	Royal Sovereign	299						
323	<b>Dover pier.</b>	70	100	14	64	93	2.4	22	South Foreland	340						
						92	5.6	4	S. Goodwin	344						
						77	10.6	4	Varne	316						
						66	12.2	4	E. Goodwin	345						
						53	18	13	Dungeness	313						
340	<b>South Foreland</b>	374		26	52	98	2.5	9	Dover pier	323						
						95	3.5	4	S. Goodwin	344						
						87	8.3	4	Gull	316						
						82	9.6	4	E. Goodwin	345						
						80	13	4	Varne	316						
						73	13.5	4	N. Goodwin	347						
						68	14.2	16	N. Foreland	355						
						62	20.2	4	Sandethé (Fr)							
						53	25.5	13	Dungeness	313						
						355	<b>North Foreland</b>	188	35	20	prob. 46	92	5.8	4	N. Goodwin	347
												91	6.7	4	Gull	346
80*	8.4	4	Tongue	362												
74	11.2	4	E. Goodwin	345												
68	13.5	4	S. Goodwin	344												
51	14.2	22	S. Foreland	340												
413	<b>Maplin.</b>	36	11 4*	11	prob. 60							88*	3.9	4	Swin middle	415
						82*	5.5	4	Mouse	411						
						83	5.8	4	Girdler	366						
417	<b>Gunfleet.</b>	41	80*	11	86	93*	4.6	4	Barrowdeep	416						
						56*	10.4	4	Cork	450						
						22*	11.4	4	Swin Middle	415						
						23*	12.4	4	Long Sand	419						
452	<b>Orfordness.</b>	93	315	15	64	85	8.2	4	Shipwash	451						
						80	11	4	Cork	450						
						77	13	4	Sunk	418						
						61	14.8	12	Southwold	454						
						27	18	4	Long Sand	419						
						20	19.5	4	Outer Gabbard	453						
						466	<b>Lowestoft</b>	123	274	17	prob. 45	96	3.8	4	Corton	468
												93	5.9	4	St. Nicholas	469
58	9.5	12	Southwold	454												
80	11	4	Cross Sand	470												
72	12.3	4	Cockle	484												
52	16.2	4	Newarp	486												

\* Red light.

OBSERVED LIGHT						OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
491	<b>Haisborough</b> . . . . .	136	35	17	prob. 50	79 80 71 70	9.5 9.6 11.7 13.9	4 4 4 4	<i>Would</i> . . . . . <i>Haisbro'</i> . . . . . <i>Cockle</i> . . . . . <i>Newarp</i> . . . . .	490 492 484 486
494	<b>Cromer</b> . . . . .	274	49	23	31	65 78 42 14	10 10 20.2 27	13 4 4 4	Haisborough . . . . . <i>Haisbro'</i> . . . . . <i>Cromer Knoll</i> . . . . . <i>E. Dudgeon</i> . . . . .	491 492 516 514
605	Tyne North Pier . . . . .	85	70	15	41	93 84 21	3 3.8 19.7	14 12 10	Souter Point . . . . . St. Mary . . . . . Coquet . . . . .	604 613 621
613	<b>St. Mary</b> . . . . .	120	374	17	prob. 40	72 46	6.8 16	14 10	Souter Point . . . . . Coquet . . . . .	604 621
616	Blyth East Pier . . . . .	63	60	13	40	88 47 46	3.2 9.9 13	12 14 10	St. Mary . . . . . Souter Point . . . . . Coquet . . . . .	613 604 621
621	<b>Coquet</b> . . . . .	83	35	14	50	34 37 11	16 18.8 22.6	12 10 14	St. Mary . . . . . Longstone . . . . . Souter Point . . . . .	613 634 604
639	<b>St. Abbs Head</b> . . . . .	224	173	21	57	84 65 53 48	11.1 19.3 21.5 24.4	12 14 18 10	Barns Ness . . . . . Bass Rock . . . . . May Island . . . . . Longstone . . . . .	640 644 725 634
640	<b>Barns ness</b> . . . . .	120	565	17	51	90 84 75 24 5	8.6 11.1 12.7 19.5 27.4	14 17 18 4 11	Bass Rock . . . . . St. Abbs Head . . . . . May Island . . . . . <i>North Carr</i> . . . . . Bell Rock . . . . .	644 639 725 728 729
644	<b>Bass Rock</b> . . . . .	150	156	18	67	94 88 54 61	4.8 8.6 16.8 19.3	12 12 17 17	Fidra Island . . . . . Barns Ness . . . . . Inchkeith . . . . . St. Abbs Head . . . . .	646 640 660 639
646	<b>Fidra Island</b> . . . . .	113	1¼	16	prob. 10	92 55 42	4.8 10.2 12	14 18 17	Bass Rock . . . . . May Island . . . . . Inchkeith . . . . .	644 725 660
660	<b>Inchkeith</b> . . . . .	220	167	21	45	71 62 44	12 16.8 21.3	12 14 18	Fidra Island . . . . . Bass Rock . . . . . May Island . . . . .	646 644 725
714	Elieness . . . . .	50	20	12	55	81 44	6.8 14	12 17	Fidra Island . . . . . Inchkeith . . . . .	646 660
725	<b>May Island</b> . . . . .	240	very powerfull	21	56	92 82 81 66 62 48 13	7 10.2 12.6 15.8 21.4 21.6 31.2	4 12 12 11 17 17 12	<i>North Carr</i> . . . . . Fidra Island . . . . . Barns Ness . . . . . Bell Rock . . . . . St. Abbs Head . . . . . Inchkeith . . . . . Scurdy Ness . . . . .	728 646 640 729 639 660 769

OBSERVED LIGHT						OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
729	<b>Bell Rock</b> . . . . .	93	392	15	67	84 59 68 8	9.6 16.2 16.2 27.7	4 18 12 13	<i>North Carr</i> . . . . . <i>May Island</i> . . . . . <i>Scurdy Ness</i> . . . . . <i>Tod Head</i> . . . . .	728 725 760 783
891	<b>Pentland Skerries</b> .	170	29	19	60	96 75 71 76 46	6 13.4 14 14.9 23.3	11 15 21 18 12	<i>Stroma</i> . . . . . <i>Noss Head</i> . . . . . <i>Dunnet Head</i> . . . . . <i>Copinsay</i> . . . . . <i>Auskerry</i> . . . . .	895 875 896 924 925
892	<b>Lothar Rock</b> . . . . .	35	4/10	10	prob. < 10	76 59 46	3 4.7 6	15 11 12	<i>Pentland Skerries</i> . . . <i>Stroma</i> . . . . . <i>Cantick Head</i> . . . . .	891 895 904
896	<b>Dunnet Head</b> . . . . .	346	141	25	prob. 50	93 93 81	5.8 8.2 14	10 11 15	<i>Holburn</i> . . . . . <i>Stroma</i> . . . . . <i>Pentland Skerries</i> . . . .	897 895 891
904	<b>Cantick Head</b> . . . . .	115	6	16	54	95 86 78 54	5.5 8.8 10.3 16	11 15 21 10	<i>Stroma</i> . . . . . <i>Pentland Skerries</i> . . . . <i>Dunnet Head</i> . . . . . <i>Holburn</i> . . . . .	895 891 896 897
924	<b>Copinsay</b> . . . . .	260	180	22	65	90 80 52	8.4 14.9 28	12 15 15	<i>Auskerry</i> . . . . . <i>Pentland Skerries</i> . . . . <i>Noss Head</i> . . . . .	925 891 875
925	<b>Auskerry</b> . . . . .	110	32	16	76	92 86 66 56	8.4 10.5 15.9 23.3	18 9 10 15	<i>Copinsay</i> . . . . . <i>Helliar Holm</i> . . . . . <i>Start Point</i> . . . . . <i>Pentland Skerries</i> . . . .	924 926 934 891
934	<b>Start Point</b> . . . . .	80	12.5	14	45	76 36 23	6.5 15.9 21.5	13 12 18	<i>North Ronaldsay</i> . . . . . <i>Auskerry</i> . . . . . <i>Noup Head</i> . . . . .	937 925 941
937	<b>North Ronaldsay</b> .	140	80	18	66	92 57 46	6.5 21.4 24.4	10 18 11	<i>Start Point</i> . . . . . <i>Noup Head</i> . . . . . <i>Scaddon</i> . . . . .	934 941 942
986	<b>Ru Stoer</b> . . . . .	195	27	20	60	42 38	23.1 26.2	15 12	<i>Tiumpnan Head</i> . . . . . <i>Rudh'Rè</i> . . . . .	1015 989
989	<b>Rudh'Rè</b> . . . . .	120	295	17	80	80 56 37 15	17.2 26.2 26.5 26.8	16 16 15 13	<i>South Rona</i> . . . . . <i>Ru Stoer</i> . . . . . <i>Tiumpnan Head</i> . . . . . <i>Glas Island</i> . . . . .	990 986 1015 1021
1048	<b>Oigh Sgeir</b> . . . . .	136	1000	17	62	55 42 33	20.6 25.9 33.7	15 15 30	<i>Adnamurchan</i> . . . . . <i>Ushinish</i> . . . . . <i>Barra Head</i> . . . . .	1056 1027 1042
1050	<b>Dubh Artach</b> . . . .	145	480	18	72	66 66 24	19.6 20.7 27.7	14 14 14	<i>Skerryvore</i> . . . . . <i>Rudha Maihl</i> . . . . . <i>Rhinn of Islay</i> . . . . .	1049 1102 1110

OBSERVED LIGHT						OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
1110	<b>Rhynns of Islay . . .</b>	150	233	18	77	60	23.6	16	Rathlin West . . . . .	1778
						59	25.2	18	Rathlin East . . . . .	1777
						20	27.7	14	Dubh Artach . . . . .	1050
						46	28.2	15	Inishtrahull . . . . .	1807
						25	32.8	19	Mull of Cantyre . . . . .	1116
1116	<b>Mull of Cantyre . . .</b>	297	281	24	61	35	13	18	Rathlin East . . . . .	1777
						63	23	11	Maidens . . . . .	1770
						49	28.5	13	Mac Arthur head . . . . .	1104
						32	32.8	14	Rhynns of Islay . . . . .	1110
1117	<b>Sanda . . . . .</b>	165	61	18	69	65	20.5	18	Rathlin East . . . . .	1777
						62	21.5	11	Maidens . . . . .	1770
						56	21.7	12	Corsewall . . . . .	1232
						14	29	14	Killantringan . . . . .	1235
1134	<b>Pladda . . . . .</b>	130	1000	17	67	84	10.5	8	Alsa Craig . . . . .	1223
						84	11.3	11	Turnberry . . . . .	1224
						75	14.5	12	Davazr . . . . .	1118
						34	25.2	12	Corsewall . . . . .	1232
1223	<b>Ailsa Craig . . . . .</b>	60	40	13	74	85	10	11	Turnberry . . . . .	1224
						77	10.5	13	Pladda . . . . .	1134
						73	14.8	12	Corsewall . . . . .	1232
						66	16	12	Holy Island . . . . .	1136
1224	<b>Turnberry . . . . .</b>	96	6	15	50	74	10	8	Ailsa Craig . . . . .	1223
						02	11.3	13	Pladda . . . . .	1134
						59	14	12	Holy Island . . . . .	1136
						18	22	12	Corsewall . . . . .	1232
						4	25.6	14	Sanda . . . . .	1117
1232	<b>Corsewall . . . . .</b>	112	95	16	68	72	14.8	8	Ailsa Craig . . . . .	1223
						65	20.5	11	Maidens . . . . .	1770
						55	21.7	14	Sanda . . . . .	1117
						42	21.7	11	Turnberry . . . . .	1224
						67	23.5	14	Black Head . . . . .	1765
						19	25.2	13	Pladda . . . . .	1134
1235	<b>Killantringan . . . .</b>	160	840	19	74	72	19.8	14	Black Head . . . . .	1765
						69	20.8	11	Maidens . . . . .	1770
						20	29	14	Sanda . . . . .	1117
1237	<b>Mull of Galloway . .</b>	325	29	25	63	72	21.2	4	Skulmartin . . . . .	1752
						52	21.8	11	Ayre Point . . . . .	1280
						67	22.7	4	South rock . . . . .	1750
						55	30.4	14	Black Head . . . . .	1765
1240	<b>Little Ross . . . . .</b>	175	69	18	54	45	22	21	St. Bees . . . . .	1279
						46	23.5	11	Ayre Point . . . . .	1280
						33	29.2	16	Maughold Head . . . . .	1302
1279	<b>St. Bees . . . . .</b>	336	35	25	47	71	14.8	4	Selker . . . . .	1311
						45	22	15	Little Ross . . . . .	1240
						40	26.5	11	Ayre Point . . . . .	1280
						45	27.1	16	Maughold Head . . . . .	1302



OBSERVED LIGHT						OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
1280	<b>Ayre Point.</b> . . . . .	106	66	16	60	48 44 43	21.8 23.5 26.5	20 15 21	Mull of Galloway. . . . . Little Ross . . . . . St. Bees . . . . .	1237 1240 1279
1467	<b>South Bishop</b> . . . . .	144	129	18	prob. 50	82 78 63	10.5 12.4 16.5	15 12 14	Skokham . . . . . Smalls . . . . . Strumble Head. . . . .	1469 1468 1466
1468	<b>Smalls</b> . . . . .	126	44	17	72	84 78 68	12.5 14.5 18.8	13 15 14	South Bishop. . . . . Skokham . . . . . St. Anns. . . . .	1467 1469 1470
1469	<b>Skokham</b> . . . . .	177	11	19	prob. 35	96 73 65 62	4.3 10.5 14.5 14.5	14 13 4 12	St. Anns. . . . . South Bishop. . . . . St. Govan. . . . . Smalls. . . . .	1470 1467 1488 1468
1470	<b>St. Anns</b> . . . . .	159	35	18	63	97 82 61	4.3 11.2 18.8	15 4 12	Skokham. . . . . St. Govan. . . . . Smalls. . . . .	1469 1488 1468
1489	<b>Clady Island.</b> . . . . .	214	35	20	57	80 76 37 30 10	12.3 14.2 25.7 28 31.6	4 4 14 15 14	Helwick . . . . . St. Govan. . . . . Lundy North. . . . . Lundy South. . . . . Bull Point . . . . .	1502 1488 1608 1609 1604
1503	<b>Mumbles.</b> . . . . .	114	8	15	53	87 27 31	7.1 18.5 20.6	4 15 17	Scarweather . . . . . Nash Point. . . . . Lynmouth Foreland. . . . .	1522 1525 1598
1524	<b>Nash Point.</b> . . . . .	184	35	19	63	82 81 79 40	10.8 12.6 14.5 27.4	4 17 4 14	Breaksea. . . . . Lynmouth Foreland. . . . . Scarweather . . . . . Bull Point . . . . .	1526 1598 1522 1604
1534	<b>Flatholm.</b> . . . . .	164	35	18	55	90 89 81 64 24	6.7 7.2 8.9 11 26.7	4 4 10 8 17	English & Welsh grounds Breaksea. . . . . Burnham . . . . . West Usk. . . . . Lynmouth Foreland. . . . .	1558 1526 1591 1544 1598
1591	<b>Burnham</b> . . . . .	91	10	15	57	79 71 20 5	8.9 12.4 23.2 30	14 4 15 17	Flatholm. . . . . Breaksea. . . . . Nash Point. . . . . Lynmouth Foreland. . . . .	1534 1526 1524 1598
1598	<b>Lynmouth Foreland</b>	220	190	21	63	83 82 66 40 5	12.6 13.6 19.3 26.7 33.6	15 4 4 14 15	Nash Point. . . . . Scarweather . . . . . Breaksea. . . . . Flatholm. . . . . Lundy South. . . . .	1525 1522 1526 1534 1609
1604	<b>Bull Point</b> . . . . .	154	182	18	66* 41**	67 67 39 23 28	17.6 18.1 18.3 20.5 27.4	15 14 4 4 15	Lundy South. . . . . Lundy North. . . . . Scarweather. . . . . Helwick . . . . . Nash Point. . . . .	1609 1608 1522 1502 1525

\* Shore observations.

\*\* Lightships observations.

OBSERVED LIGHT						OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
1608	<b>Lundy North</b> . . . . .	165	374	19	68* 43**	71 32 44 7	18.1 20.7 26.7 33.6	14 4 16 17	<b>Bull Point</b> . . . . . <i>Helwick</i> . . . . . <b>Caldy Island</b> . . . . . <b>Lynmouth Foreland</b> . . . . .	1604 1502 1489 1598
1609	<b>Lundy South</b> . . . . .	175	206	19	63	91 71 64 18 37 7	9.7 17.6 18.1 22.5 28 33.6	12 14 11 4 16 17	<b>Hartland Point</b> . . . . . <b>Bull Point</b> . . . . . <b>Bideford</b> . . . . . <i>Helwick</i> . . . . . <b>Caldy Island</b> . . . . . <b>Lynmouth Foreland</b> . . . . .	1613 1604 1606 1502 1489 1598
1627	<b>Pendeen</b> . . . . .	195	190	20	68	76 47 5	16.8 27.8 34	4 15 16	<i>Seven Stones</i> . . . . . <b>Round Island</b> . . . . . <b>Trevose</b> . . . . .	7 6 1616
1638	<b>Old Head of Kinsale</b>	236	460	21	69	87 77 62	12 16.2 24.3	4 15 16	<b>Daunt Rock</b> . . . . . <b>Galley Head</b> . . . . . <b>Ballycotton</b> . . . . .	1640 1636 1669
1669	<b>Ballycotton</b> . . . . .	195	160	20	65	85 72 48	12.2 17.9 24.3	4 19 17	<b>Daunt Rock</b> . . . . . <b>Minehead</b> . . . . . <b>Old Head of Kinsale</b> . . . . .	1640 1671 1638
1694	<b>Tuskar</b> . . . . .	108	340	16	60	84 52 35	9.3 19.5 19.5	4 4 4	<i>Lucifer Bank</i> . . . . . <i>Blackwater Bank</i> . . . . . <i>Coningbeg</i> . . . . .	1697 1699 1691
1703	<b>Wicklow Head</b> . . . . .	121	120	17	64	84 38 45	11 18.4 23.7	4 4 13	<b>Codling</b> . . . . . <b>Arklow</b> . . . . . <b>Bailey</b> . . . . .	1707 1700 1723
1716	<b>Poolbeg</b> . . . . .	66	3	12	prob. 80	99 97 89	2.5 3.7 8.8	8 13 4	<b>Kingstown E. pier</b> . . . . . <b>Bailey</b> . . . . . <b>Kish</b> . . . . .	1712 1723 1710
1723	<b>Bailey</b> . . . . .	134	950	17	77	98 98 53 65	4.4 5.4 21.5 23.7	8 4 4 12	<b>Kingstown E. pier</b> . . . . . <b>Kish</b> . . . . . <i>Codling Bank</i> . . . . . <b>Wicklow Head</b> . . . . .	1712 1710 1707 1703
1753	<b>Donaghadee</b> . . . . .	56	1	12	prob. 45	97 85 79	3.2 7.5 9	12 4 14	<b>Mew Island</b> . . . . . <b>Skulmartin</b> . . . . . <b>Black Head</b> . . . . .	1754 1752 1765
1754	<b>Mew Island</b> . . . . .	121	177	17	65	96 90 74 64 47 41	7.5 10 15.7 16 22.5 23.3	14 4 11 14 12 20	<b>Black Head</b> . . . . . <b>Skulmartin</b> . . . . . <b>Maidens</b> . . . . . <b>Killantringan</b> . . . . . <b>Corsewall</b> . . . . . <b>Mull of Galloway</b> . . . . .	1765 1752 1770 1235 1232 1237
1765	<b>Black Head</b> . . . . .	148	165	18	69	93 61 58 35	7.5 19.8 23.5 30.7	12 14 12 20	<b>Mew Island</b> . . . . . <b>Killantringan</b> . . . . . <b>Corsewall</b> . . . . . <b>Mull of Galloway</b> . . . . .	1754 1235 1232 1237

\* Shore observations.

\*\* Lightships observations.

OBSERVED LIGHT						OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility at geogr. range in miles	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10	11
1770	<b>Maidens . . . . .</b>	95	270	15	81	99	5.3	7	Farres Point . . . . .	1767
						81	15.7	12	Mew Island . . . . .	1754
						62	20.5	12	Corsewall . . . . .	1232
						62	20.8	14	Killantringan . . . . .	1335
						61	21.5	14	Sanda . . . . .	1117
						59	23	19	Mull of Cantyre . . . . .	1116
						51	27.3	18	Rathlin East . . . . .	1777
1777	<b>Rathlin East . . . . .</b>	243	230	22	61	80	13	19	Mull of Cantyre . . . . .	1116
						64	20.5	14	Sanda . . . . .	1117
						52	25.2	14	Rhinn of Islay . . . . .	1110
						53	27.3	11	Maidens . . . . .	1770
1778	<b>Rathlin West . . . . .</b>	204	250	20	50	37	22.5	9	Innishowen . . . . .	1784
						41	23.6	14	Rhinn of Islay . . . . .	1110
						34	33.5	15	Inishtrahull . . . . .	1807
1807	<b>Inishtrahull . . . . .</b>	181	200	19	72	89	16.3	13	Fanad Head . . . . .	1808
						39	28.2	14	Rhinn of Islay . . . . .	1110
						13	33.3	16	Rathlin West . . . . .	1778

# APPENDIX 2.

## II. OBSERVATIONS OF LIGHT-VESSELS.

OBSERVED LIGHT-VESSEL					OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10
209	<i>Calshot Spit</i> . . . . .	33	0.75	10	29	9.6	4	<i>Warner</i> . . . . .	268
369	<i>Nore</i> . . . . .	35	2	11	79 70	6.1 7.7	4 7	<i>Mouse</i> . . . . . <i>Chapman</i> . . . . .	411 393
450	<i>Cork</i> . . . . .	35	2	10	49 37	10.4 11	7 11	<i>Gunfleet</i> . . . . . <i>Ordfordness</i> . . . . .	417 452
367	<i>Edinburgh</i> . . . . .	34	2.5	10	86 75 82	5.3 7.5 7.6	4 4 6	<i>Tongue</i> . . . . . <i>Girdler</i> . . . . . <i>Maplin</i> . . . . .	362 366 413
532	<i>Middle</i> . . . . .	21	2.5	7	42	5.3	12	<i>Spurn</i> . . . . .	520
522	<i>Bull</i> . . . . .	32	4.5	11	96 69	1.4 7.8	12 4	<i>Spurn</i> . . . . . <i>Humber</i> . . . . .	520 519
316	<i>Varne</i> . . . . .	36	5	11	25 32	10.6 11.6	9 13	<i>Dover Pier</i> . . . . . <i>Dungeness</i> . . . . .	323 313
469	<i>St-Nicholas</i> . . . . .	36	5	11	90 70	4 6.2	4 4	<i>Corton</i> . . . . . <i>Cockle</i> . . . . .	468 484
137	<i>Shambles</i> . . . . .	38	8	11	94 93 49	4.5 5.5 15	13 9 14	<i>Portland Bill</i> . . . . . <i>Portland Breakwater</i> <i>Anvil Point</i> . . . . .	122 128 177
344	<i>South Goodwin</i> . . . . .	36	8	11	91 83 86	5.6 6.7 6.8	9 4 4	<i>Dover Pier</i> . . . . . <i>East Goodwin</i> . . . . . <i>Gull</i> . . . . .	323 345 346
346	<i>Gull</i> . . . . .	35	8	10	87 84 69 78	5.5 5.7 6.7 6.8	4 4 16 4	<i>North Goodwin</i> . . . . . <i>East Goodwin</i> . . . . . <i>North Foreland</i> . . . . . <i>South Goodwin</i> . . . . .	347 345 355 344
362	<i>Tongue</i> . . . . .	40	8 R 6	11	83 71	5.3 8.4	4 16	<i>Edinburgh</i> . . . . . <i>North Foreland</i> . . . . .	367 355
416	<i>Barrow Deep</i> . . . . .	38	8	11	91	4.6	7	<i>Gunfleet</i> . . . . .	417
418	<i>Sunk</i> . . . . .	39	8	11	85 46 22 30	5.2 9.4 11.4 13	4 4 4 11	<i>Longsand</i> . . . . . <i>Cork</i> . . . . . <i>Shipwash</i> . . . . . <i>Ordfordness</i> . . . . .	419 450 451 452

OBSERVED LIGHT-VESSEL					OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10
451	<i>Shipwash</i> . . . . .	39	8	11	70 16	8.2 11.4	11 4	<i>Ordfordness</i> . . . . . <i>Outer Gabbard</i> . . . . .	452 453
453	<i>Outer Gabbard</i> . . . . .	40	8	11	22	11.4	4	<i>Shipwash</i> . . . . .	451
468	<i>Corton</i> . . . . .	36	8	11	93	3.7	12	<i>Lowestoft</i> . . . . .	466
470	<i>Cross Sand</i> . . . . .	39	8	11	84 82 82 81 55 21	6.4 6.5 6.5 7.4 11 18	4 4 4 4 12 13	<i>St. Nicholas</i> . . . . . <i>Cockle</i> . . . . . <i>Newarp</i> . . . . . <i>Corton</i> . . . . . <i>Lowestoft</i> . . . . . <i>Haisborough</i> . . . . .	469 484 486 468 466 491
487	<i>Smiths Knoll</i> . . . . .	38	8	11	10	13.9	4	<i>Newarp</i> . . . . .	486
490	<i>Would</i> . . . . .	39	8	11	62 63 20 18	8.6 9.5 11.7 19	4 13 4 19	<i>Cockle</i> . . . . . <i>Haisborough</i> . . . . . <i>Haisbro'</i> . . . . . <i>Cromer</i> . . . . .	484 491 492 494
492	<i>Haisbro'</i> . . . . .	40	8	11	61 52	9.6 10	13 19	<i>Haisborough</i> . . . . . <i>Cromer</i> . . . . .	491 494
514	<i>Dudgeon</i> . . . . .	36	8 R 8	10	9 7	11.3 27	4 19	<i>Cromer Knoll</i> . . . . . <i>Cromer</i> . . . . .	516 494
516	<i>Cromer Knoll</i> . . . . .	38	8	11	9 8	11.3 20.2	4 19	<i>Dudgeon</i> . . . . . <i>Cromer</i> . . . . .	514 494
1311	<i>Selker</i> . . . . .	30	8	11	43	14.9	21	<i>St. Bees</i> . . . . .	1279
1443	<i>Carnarvon Bay</i> . . . . .	36	8 R 6	11	58	13.3	16	<i>South Stack</i> . . . . .	1442
1522	<i>Scarweather</i> . . . . .	38	8	11	47 44 34	13.6 14.5 18.3	17 15 14	<i>Lynmouth Foreland</i> . . . . . <i>Nash West</i> . . . . . <i>Bull Point</i> . . . . .	1598 1525 1604
1697	<i>Lucifer</i> . . . . .	38	8	11	65 33	9.3 10	12 4	<i>Tuskar</i> . . . . . <i>Blackwater</i> . . . . .	1694 1699
728	<i>North Carr</i> . . . . .	36	9	11	70 56 24	7 9.6 15.9	18 11 12	<i>May Island</i> . . . . . <i>Bell Rock</i> . . . . . <i>Fidra</i> . . . . .	725 729 646
7	<i>Seven Stones</i> . . . . .	38	12	11	79 64 56 52	11 12.4 12.8 16.8	15 12 12 16	<i>Round Island</i> . . . . . <i>Wolf Rock</i> . . . . . <i>Longships</i> . . . . . <i>Pendeen</i> . . . . .	6 11 10 1627
299	<i>Royal Sovereign</i> . . . . .	38	12	11	78	7.6	11	<i>Beachy Head</i> . . . . .	298
347	<i>North Goodwin</i> . . . . .	40	12	11	89 85	5.5 5.8	4 16	<i>Gull</i> . . . . . <i>North Foreland</i> . . . . .	346 355

OBSERVED LIGHT-VESSEL					OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10
486	<i>Newarp</i> . . . . .	39	12	11	87 84 82 40 43 10	6.5 6.5 6.5 13.9 16.2 24.5	4 4 4 13 12 19	<i>Cockle</i> . . . . . <i>Cross Sand</i> . . . . . <i>Would</i> . . . . . <i>Haisborough</i> . . . . . <i>Lowestoft</i> . . . . . <i>Cromer</i> . . . . .	484 470 490 491 466 494
1526	<i>Breaksea</i> . . . . .	37	12	11	83 70 23	7.2 10.8 19.3	14 15 17	<i>Flatholm</i> . . . . . <i>Nash Point</i> . . . . . <i>Lynmouth Foreland</i> . . . . .	1534 1525 1598
1558	<i>English &amp; Welsh Grounds</i>	38	12	11	82 83	5.6 6.7	8 14	<i>West Usk</i> . . . . . <i>Flatholm</i> . . . . .	1544 1534
1700	<i>Arklow</i> . . . . .	38	12	11	66 35	9.9 18.4	4 12	<i>Blackwater</i> . . . . . <i>Wicklow Head</i> . . . . .	1699 1703
1710	<i>Kish</i> . . . . .	38	12	11	94 83 63 5	5.4 7.8 16.7 17	13 8 14 4	<i>Bailey</i> . . . . . <i>Kingstown East Pier</i> . . . . . <i>Rockabill</i> . . . . . <i>Codling</i> . . . . .	1723 1712 1727 1707
1750	<i>South Rock</i> . . . . .	38	12	11	85 4	8.2 22.3	4 20	<i>Skulmartin</i> . . . . . <i>Mull of Galloway</i> . . . . .	1751 1237
419	<i>Longsand</i> . . . . .	40	16	11	89 75 49	5.2 8.4 11.1	4 4 4	<i>Sunk</i> . . . . . <i>Kentish Knock</i> . . . . . <i>Gallopers</i> . . . . .	418 420 421
345	<i>East Goodwin</i> . . . . .	36	20	11	89 84 82 62 48	5.7 6.6 6.7 9.6 12.2	4 4 4 22 9	<i>Gull</i> . . . . . <i>North Goodwin</i> . . . . . <i>South Goodwin</i> . . . . . <i>South Foreland</i> . . . . . <i>Dover Pier</i> . . . . .	346 347 344 340 323
484	<i>Cockle</i> . . . . .	35	20	10	85 84 83 60 43 45	5.5 6.2 6.5 8.6 11.7 12.3	4 4 4 4 13 12	<i>Newarp</i> . . . . . <i>St. Nicholas</i> . . . . . <i>Cross Sand</i> . . . . . <i>Would</i> . . . . . <i>Haisborough</i> . . . . . <i>Lowestoft</i> . . . . .	486 469 470 490 491 466
519	<i>Humber</i> . . . . .	40	20	11	82	6.9	12	<i>Spurn</i> . . . . .	520
1488	<i>St-Goven</i> . . . . .	40	20	11	61 45 51	11.2 14.2 14.5	14 16 15	<i>St. Anns</i> . . . . . <i>Caldy Island</i> . . . . . <i>Skokham</i> . . . . .	1470 1489 1469
1502	<i>Helwick</i> . . . . .	39	20	11	55 20 19	12.3 20.5 20.7	16 14 14	<i>Caldy</i> . . . . . <i>Bull Point</i> . . . . . <i>Lundy North</i> . . . . .	1489 1604 1608
1699	<i>Blackwater</i> . . . . .	38	20	11	77 74 28	9.9 10 19.5	4 4 12	<i>Arklow</i> . . . . . <i>Lucifer</i> . . . . . <i>Tuskar</i> . . . . .	1700 1697 1694

OBSERVED LIGHT-VESSEL					OBSERVING LIGHTS				
Number in light-list 1923	NAME	Height in feet above high-water	Candle power in 1000	Geogr. range in miles, eye 15 feet	Percentage of visibility of light observed	Distance from light observed in miles	Distance of horizon of observer in miles	NAME	Number in light-list 1923
1	2	3	4	5	6	7	8	9	10
415	<i>Swin Middle</i> . . . . .	32	25	10	95 65 45	3.9 8 11.4	6 4 7	Maplin. . . . . <i>Edinburgh</i> . . . . . Gunfleet. . . . .	413 367 417
1640	<i>Daunt Rock</i> . . . . .	38	28	10	93 49 60	4.9 12 12.2	11 17 16	Roche Point . . . . . Old Head of Kinsale. . . . . Ballycotton. . . . .	1641 1638 1669
1692	<i>Barrels</i> . . . . .	38	28	11	65 23	9.1 10.6	12 4	Tuskar . . . . . <i>Coningbeg</i> . . . . .	1694 1691
1707	<i>Codling</i> . . . . .	38	28	11	64	10.8	12	Wicklow Head . . . . .	1703
1751	<i>Skulmartin</i> . . . . .	38	28	11	88 71	8.2 10	4 12	<i>South Rock</i> . . . . . Mew Island. . . . .	1750 1754
411	<i>Mouse</i> . . . . .	32	35	11	85 79	5.5 6.1	6 4	Maplin . . . . . <i>Nore</i> . . . . .	413 369
1691	<i>Coningbeg</i> . . . . .	38	70	11	75 84 33	10.6 11.3 19.5	4 14 12	<i>Barrels</i> . . . . . Hook Point . . . . . Tuskar . . . . .	1691 1677 1694
366	<i>Girdler</i> . . . . .	31	140	10	93 92 81	5.2 5.8 7.5	4 6 4	<i>Mouse</i> . . . . . Maplin . . . . . <i>Edinburgh</i> . . . . .	411 413 367
420	<i>Kentish Knock</i> . . . . .	38	180	11	75 48	8.4 12.3	4 4	<i>Longsand</i> . . . . . <i>Galloper</i> . . . . .	419 421



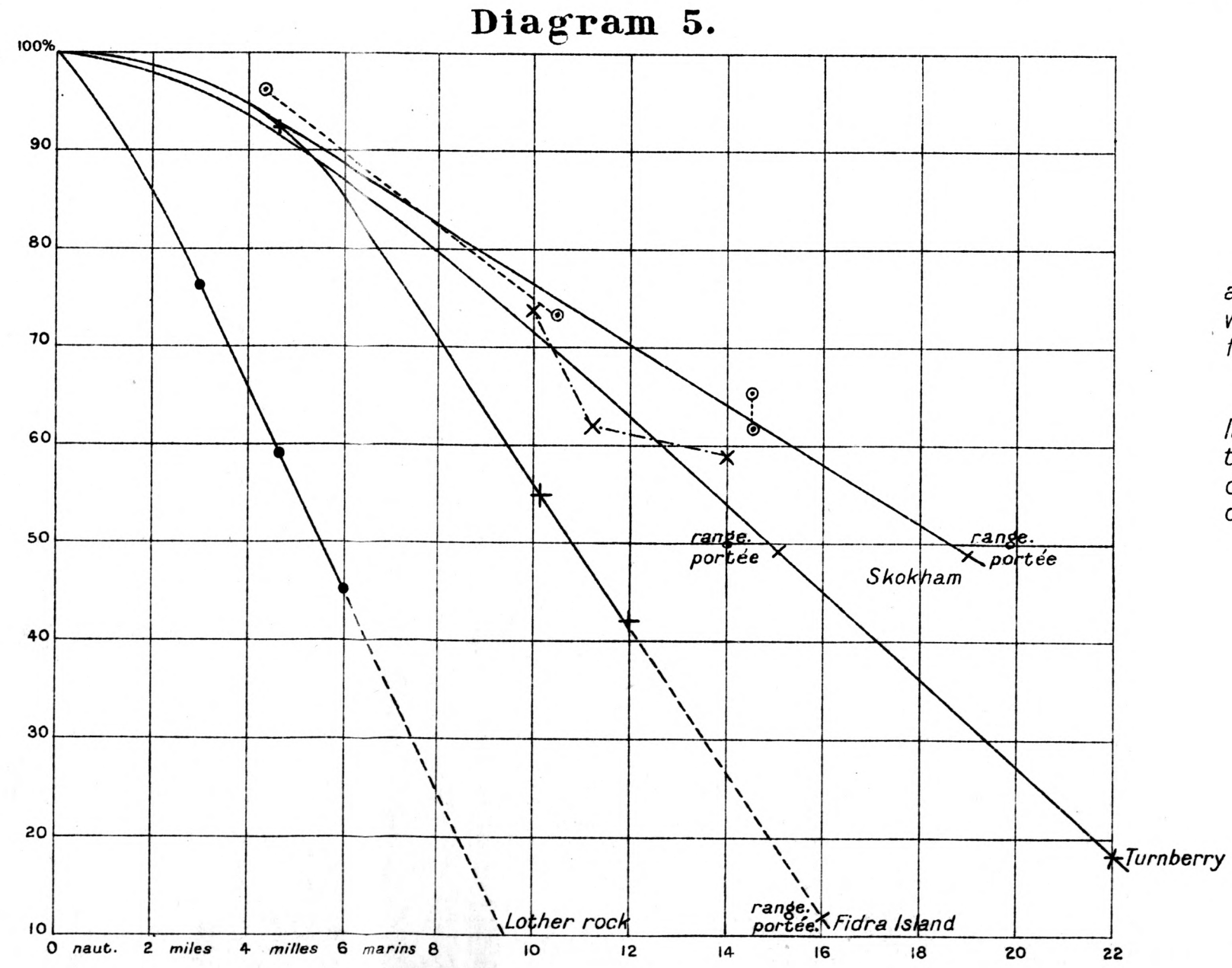
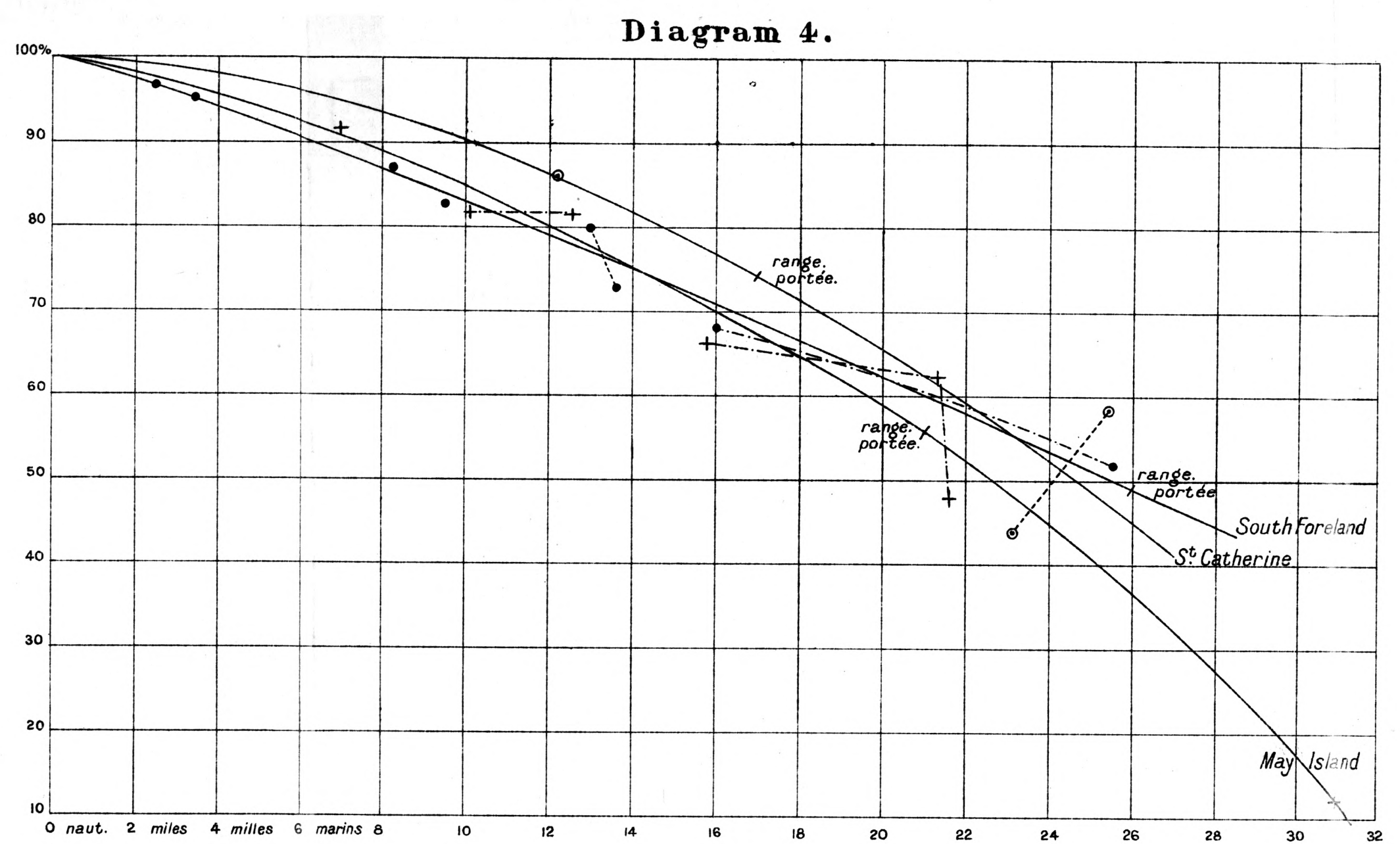
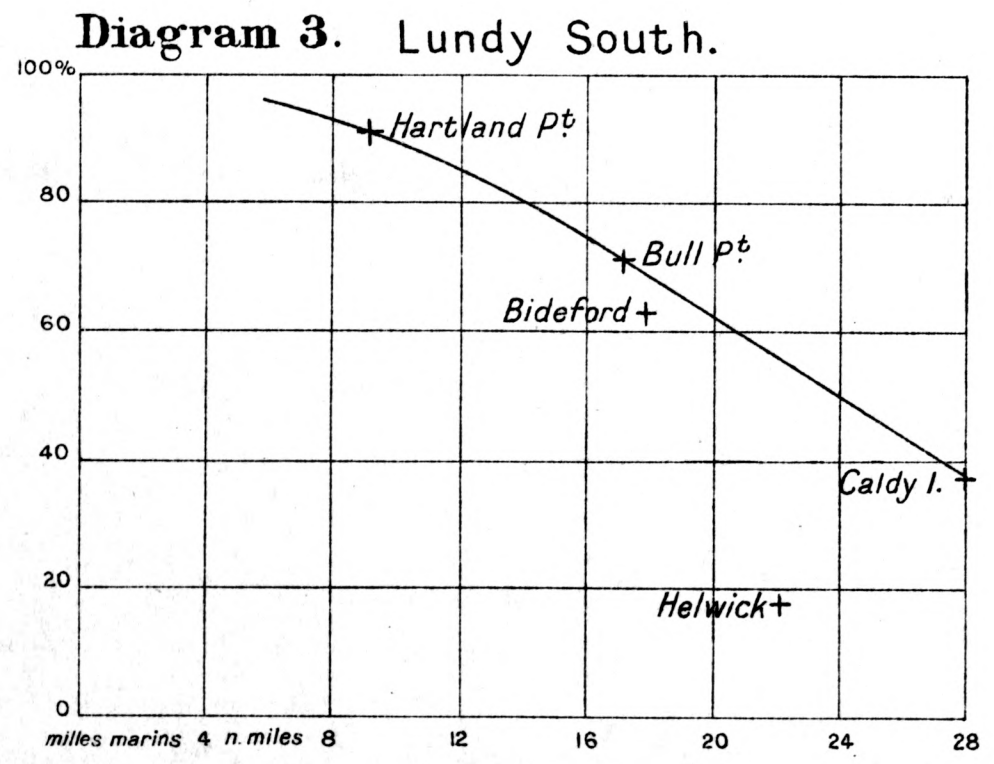
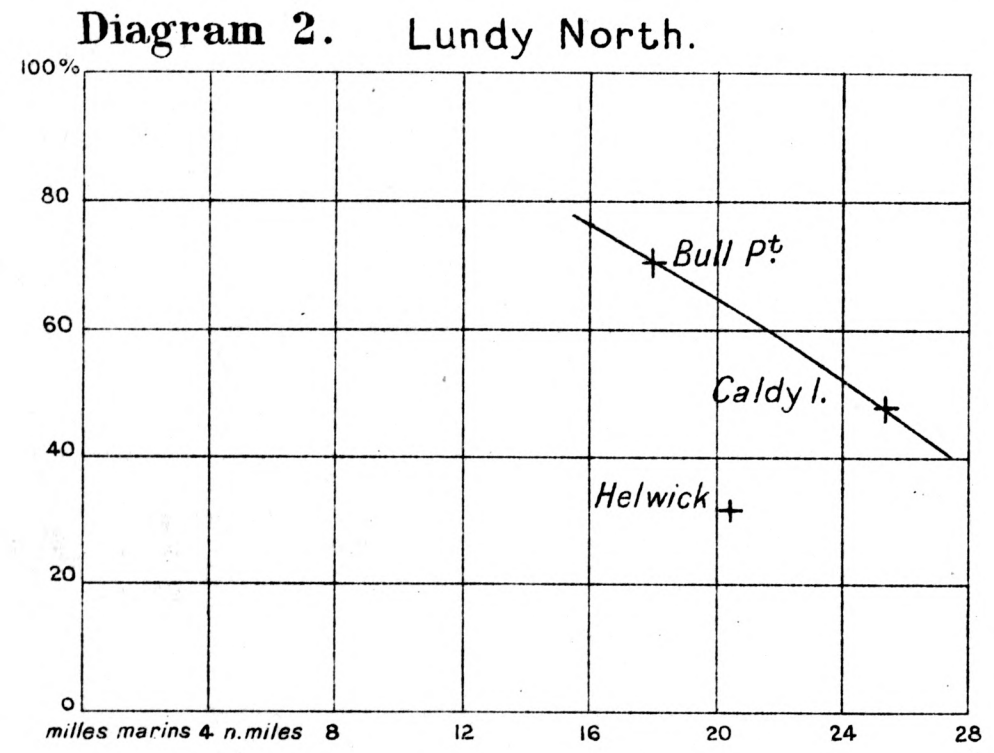
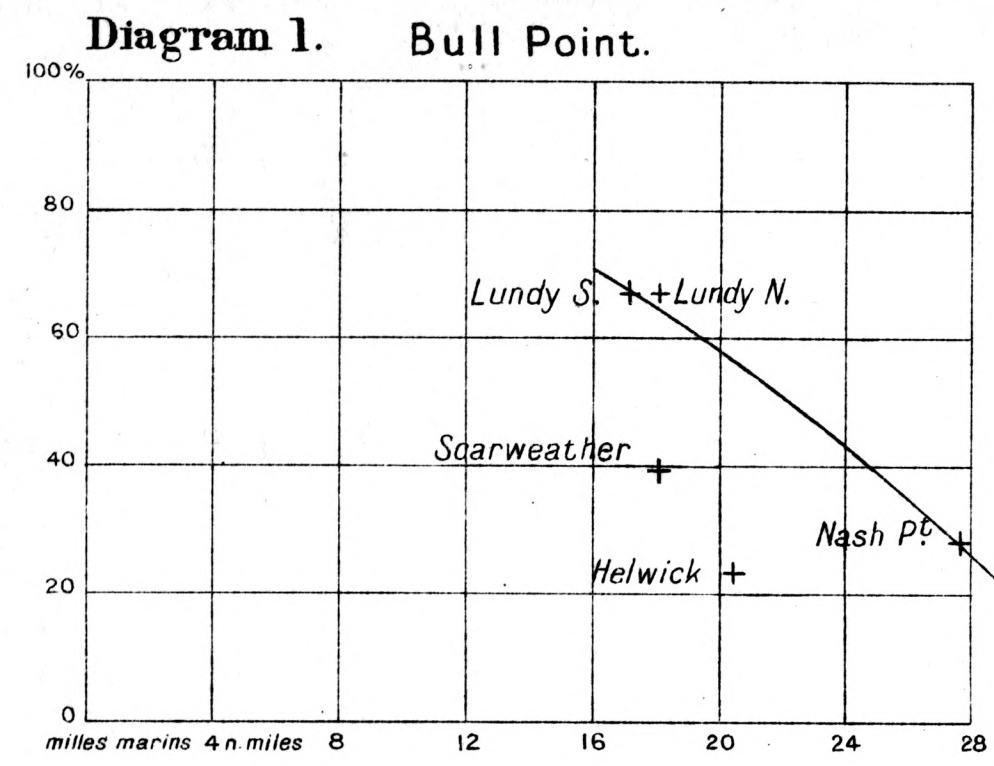
APPENDIX 3.

PERCENTAGES OF VISIBILITY OF LIGHTSHIPS

Distance in Nautical miles

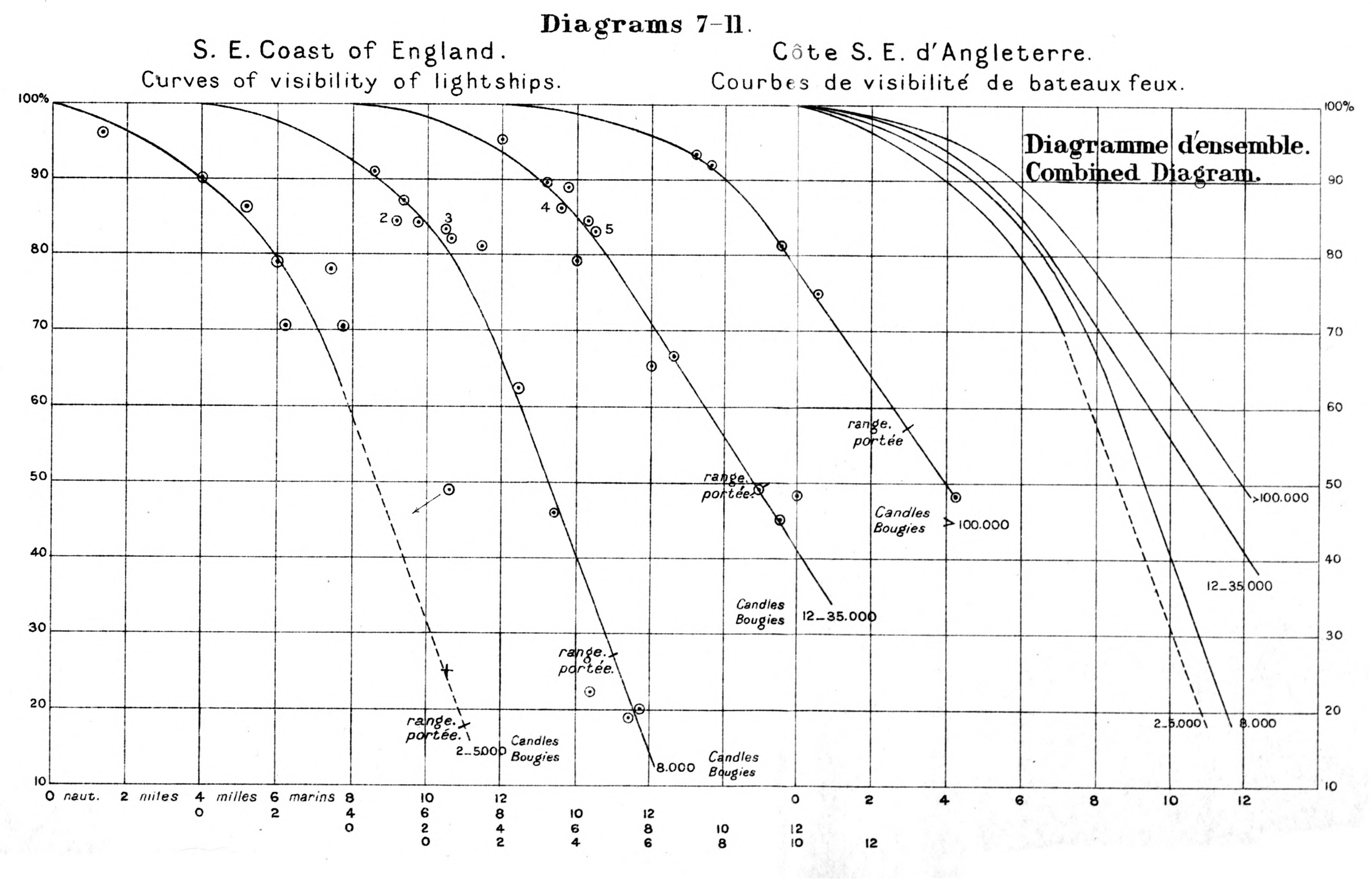
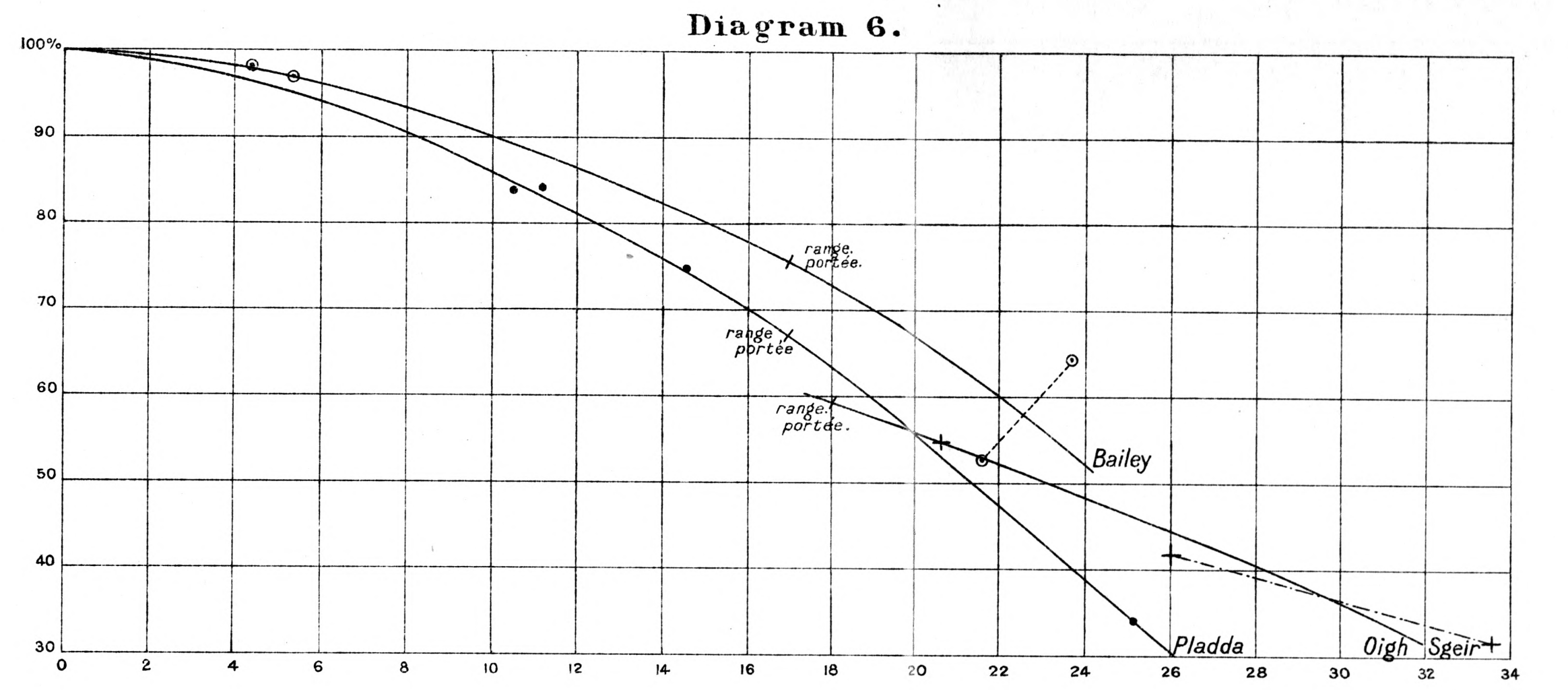
Table with 34 columns for distance (3.75 to 20) and rows for ship names and visibility percentages. Includes sections: S. E. COAST OF ENGLAND., CHANNEL., SCOTLAND EAST COAST., and ENGLAND W. COAST. IRELAND S. & E. COASTS.





The "range" is the distance at which a light is seen in clear weather from a height of 15 feet.

La "portée" est la distance à laquelle un feu est visible par temps clair, supposant l'œil de l'observateur à une hauteur de 4,50 mètres.





**PLATE 1.**

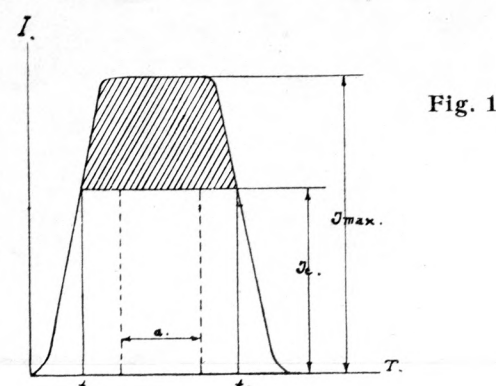


Fig. 1

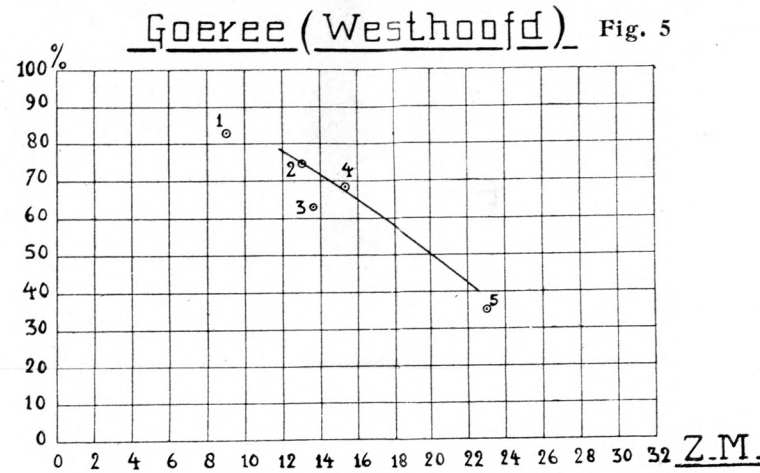


Fig. 5

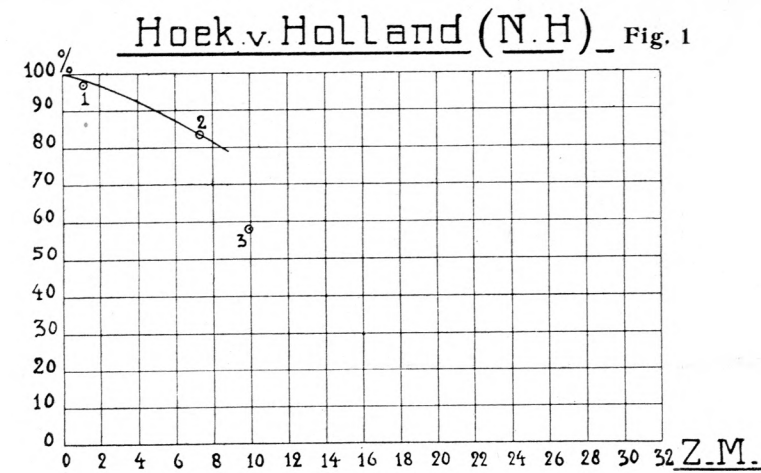


Fig. 1

**PLATE 2.**

Fig. 3

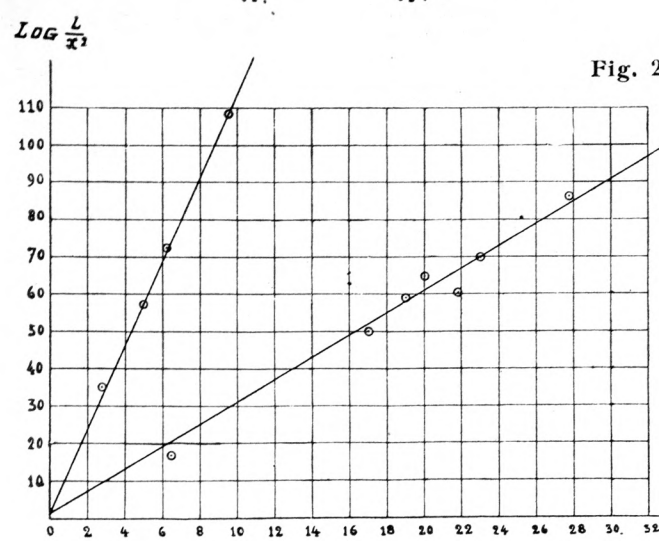
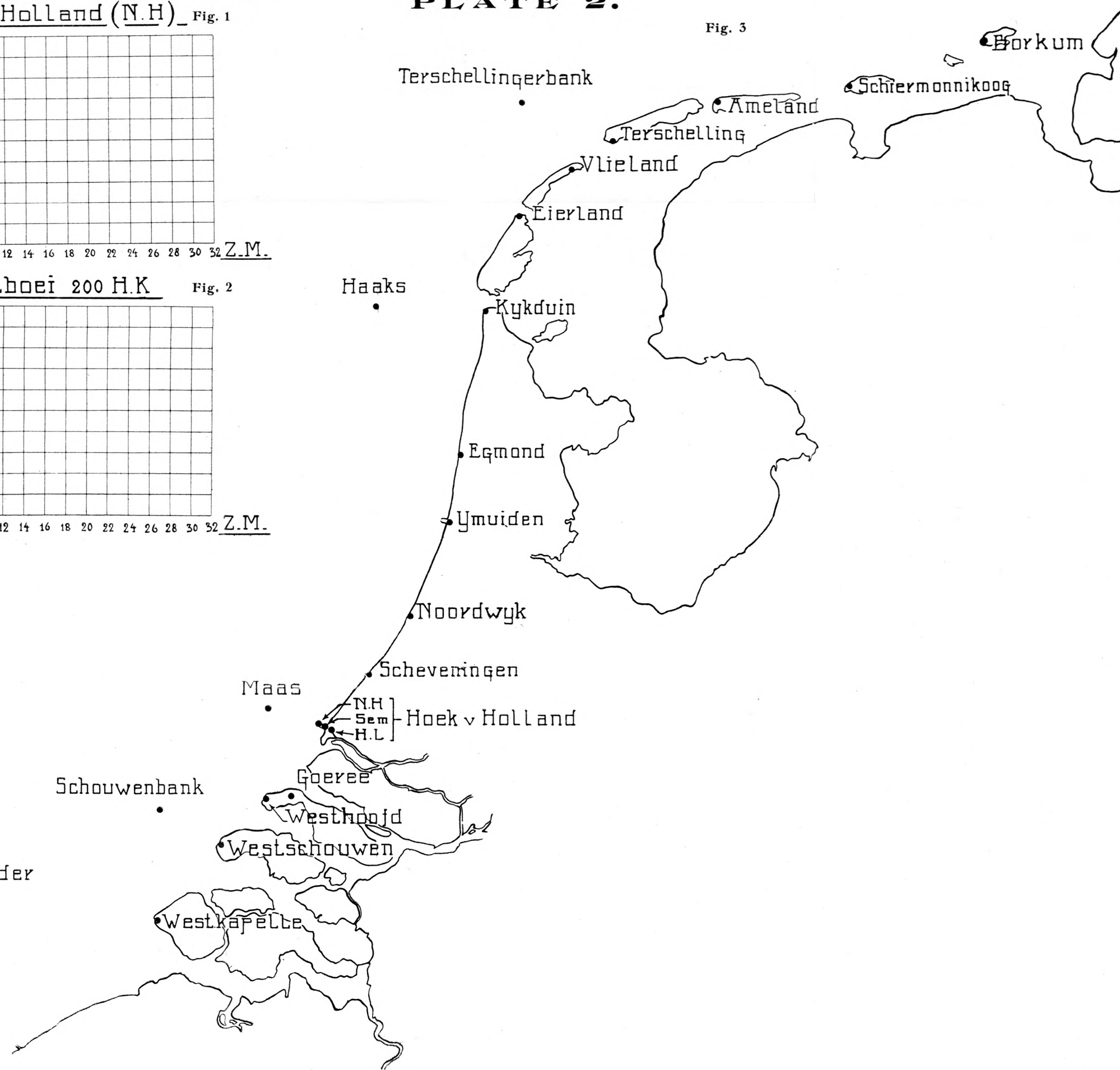


Fig. 2

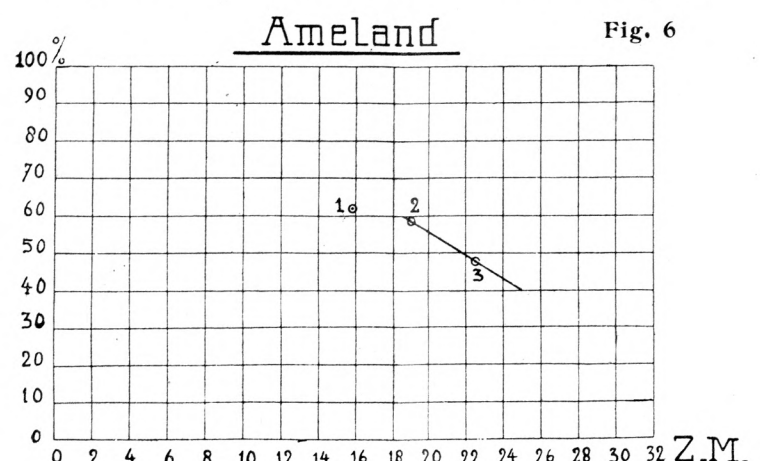


Fig. 6

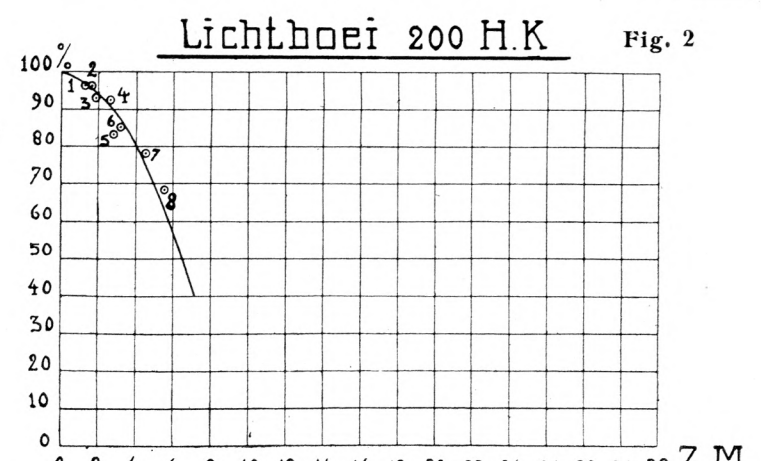


Fig. 2

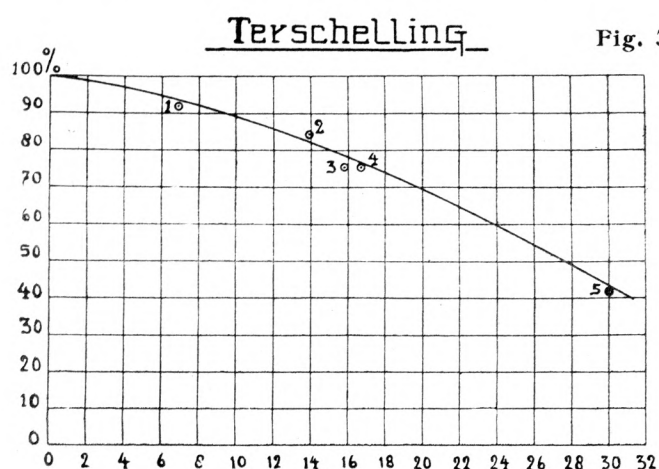


Fig. 3

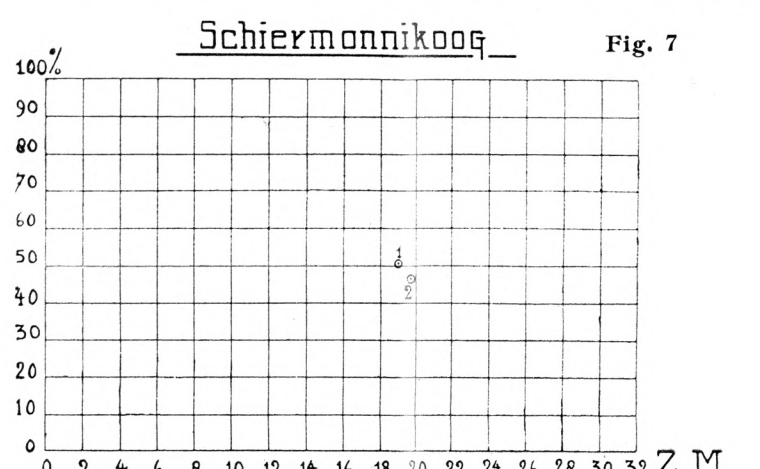


Fig. 7

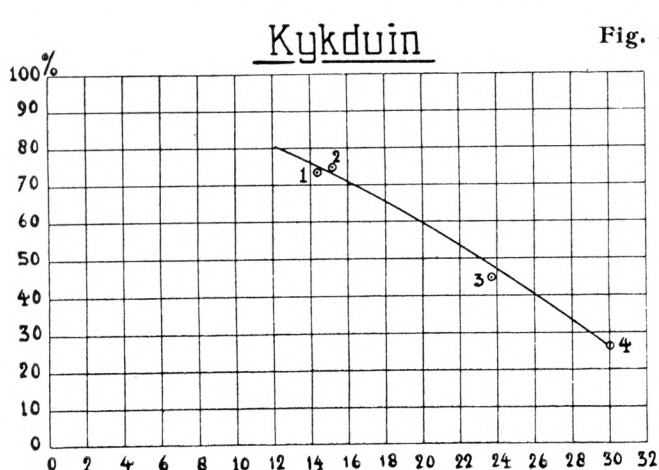


Fig. 4

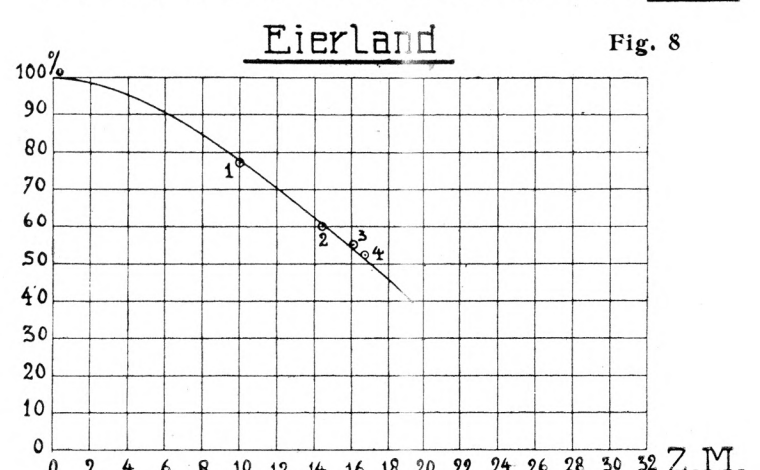


Fig. 8

**PLATE 3.**

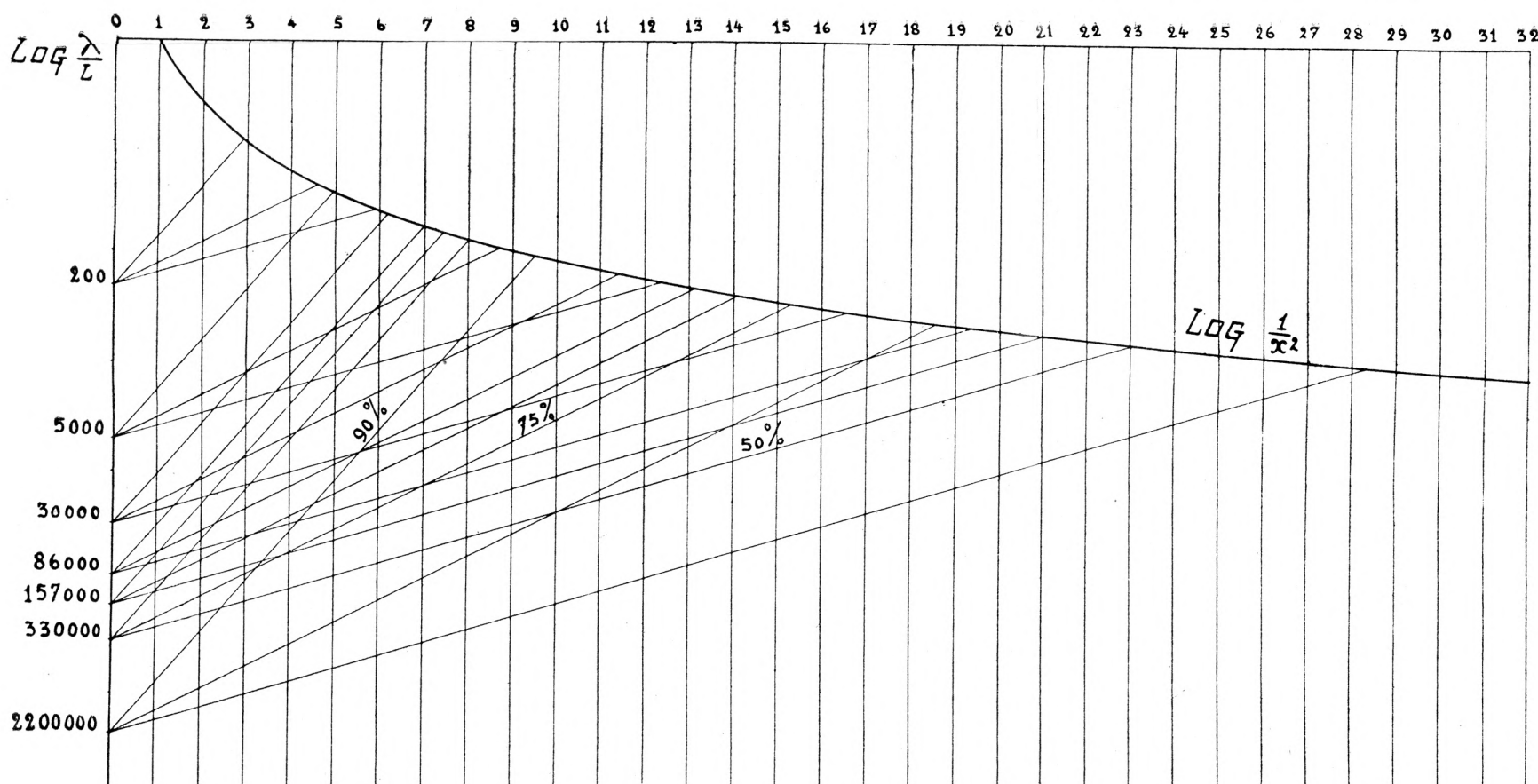


Fig. 1

PLATE 3.

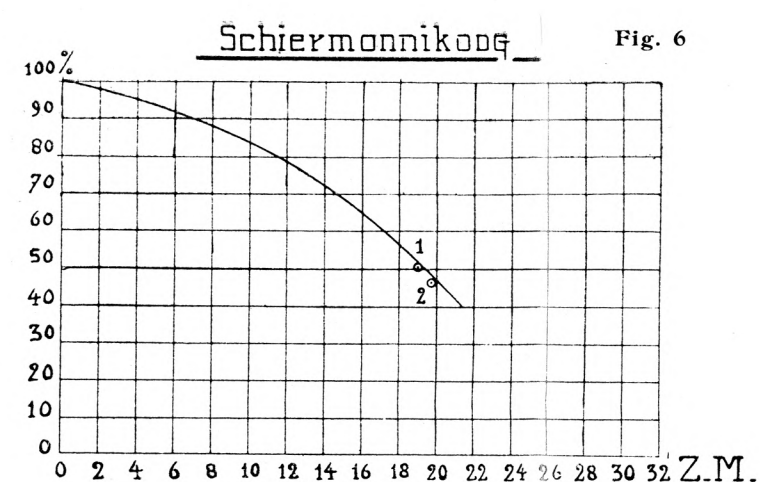


Fig. 6

**PLATE 4.**

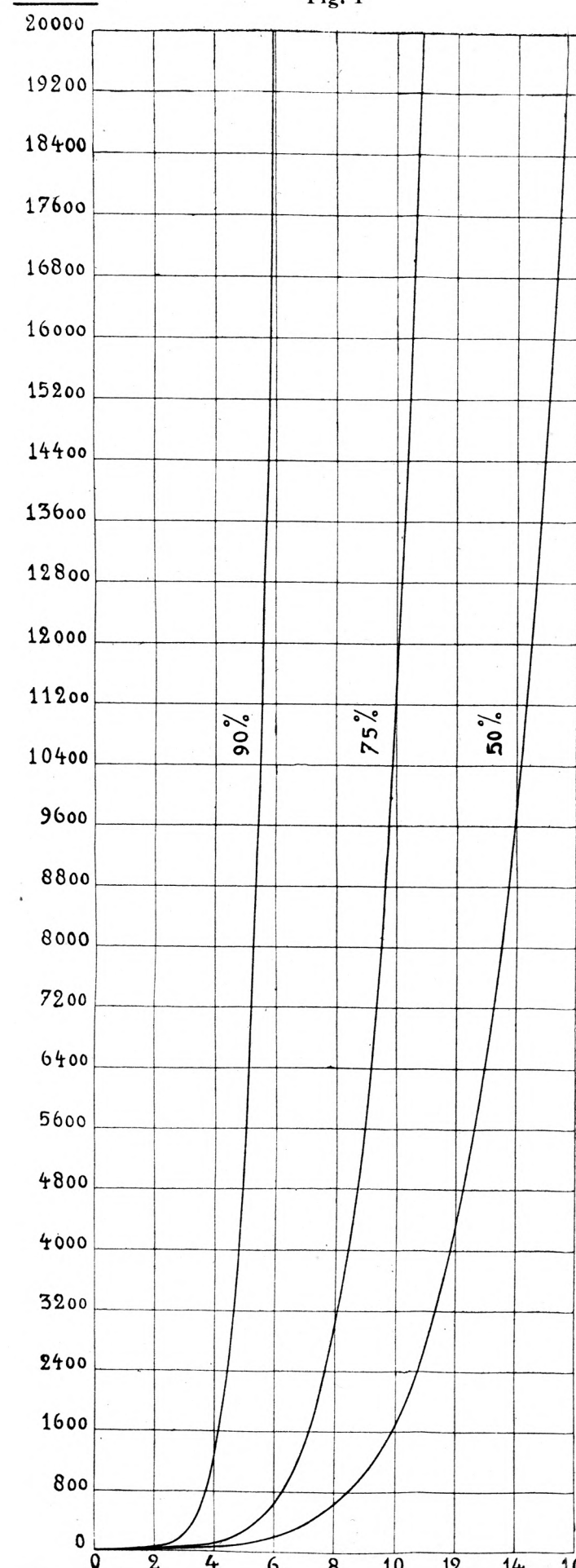


Fig. 1

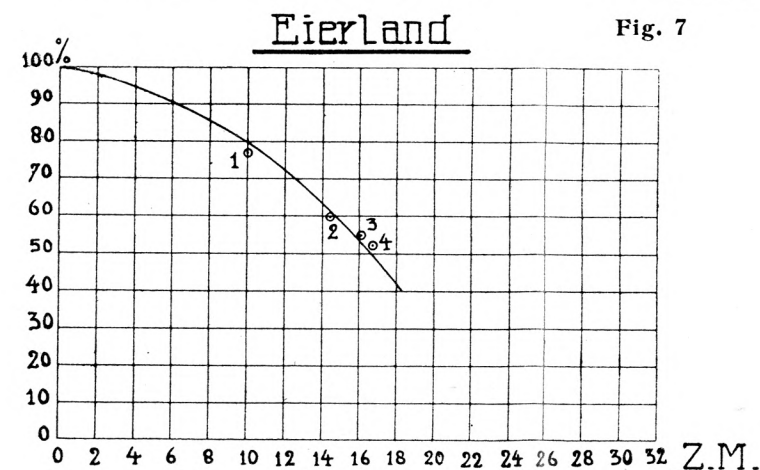


Fig. 7

**PLATE 4.**

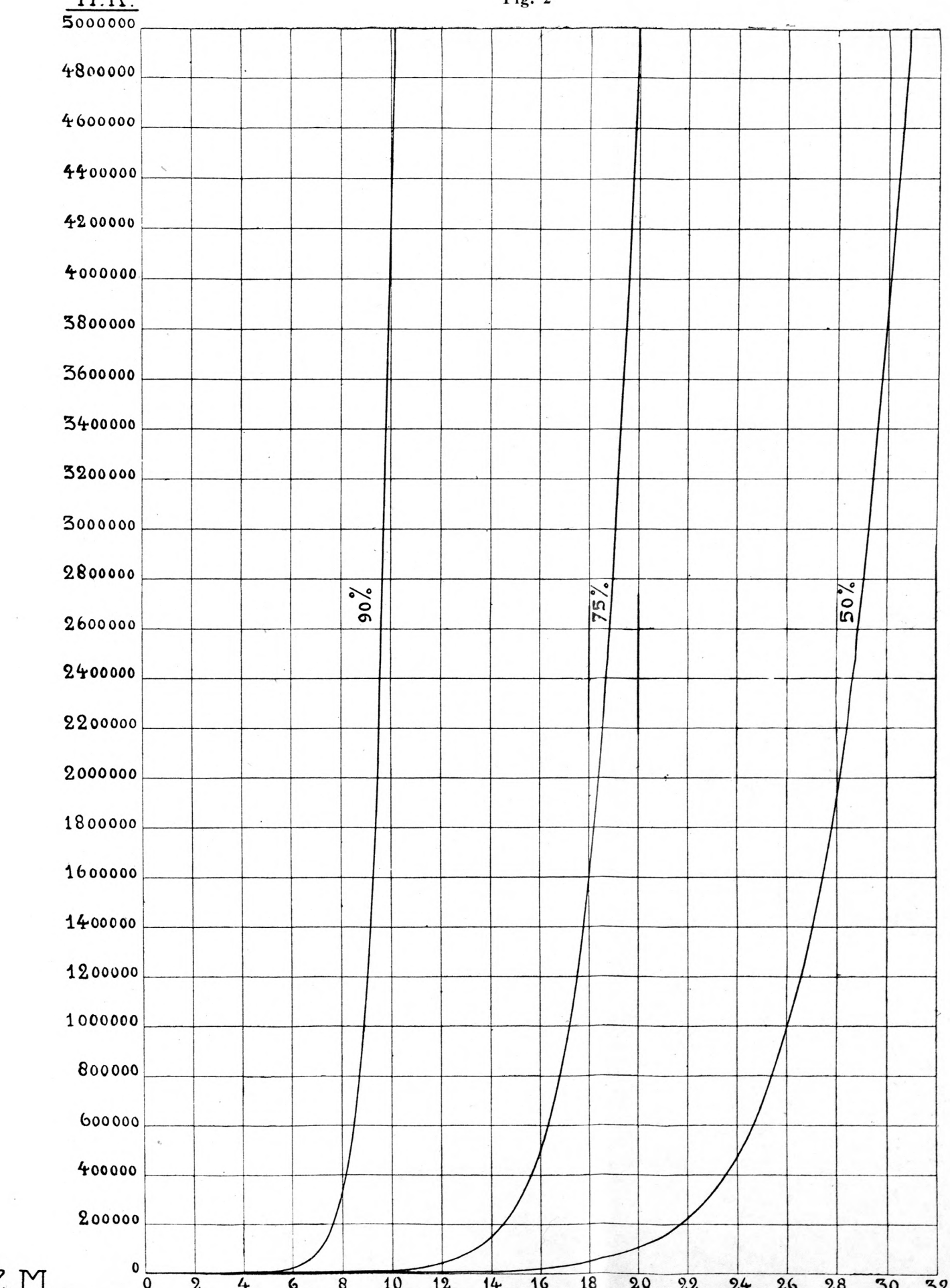


Fig. 2

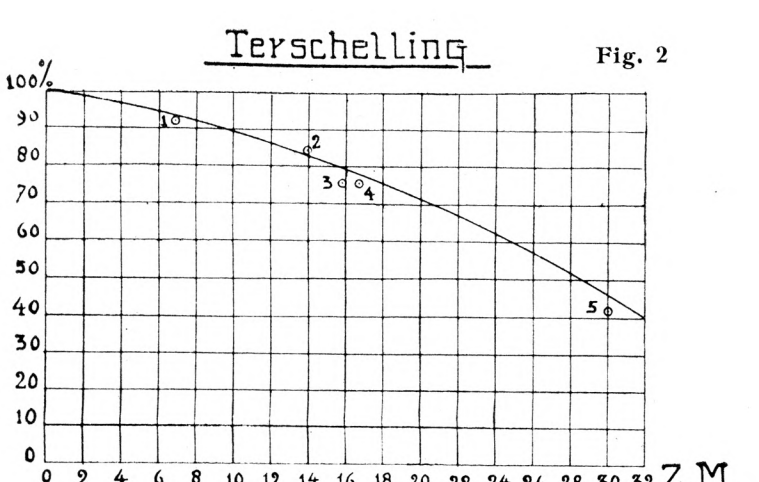


Fig. 2

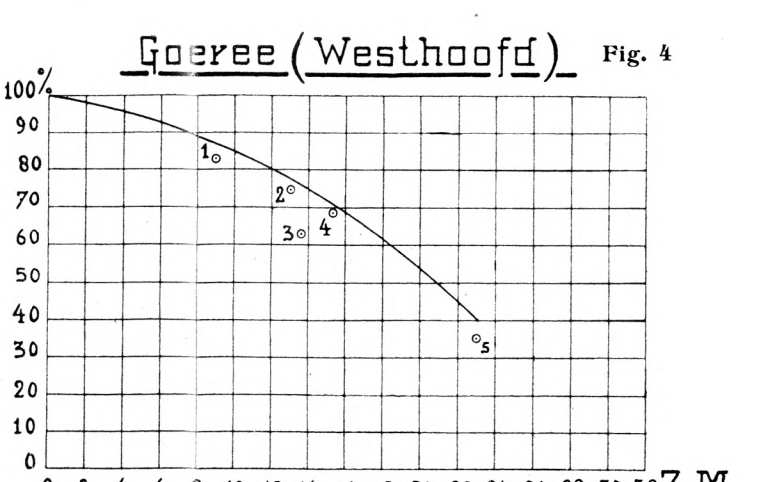


Fig. 4

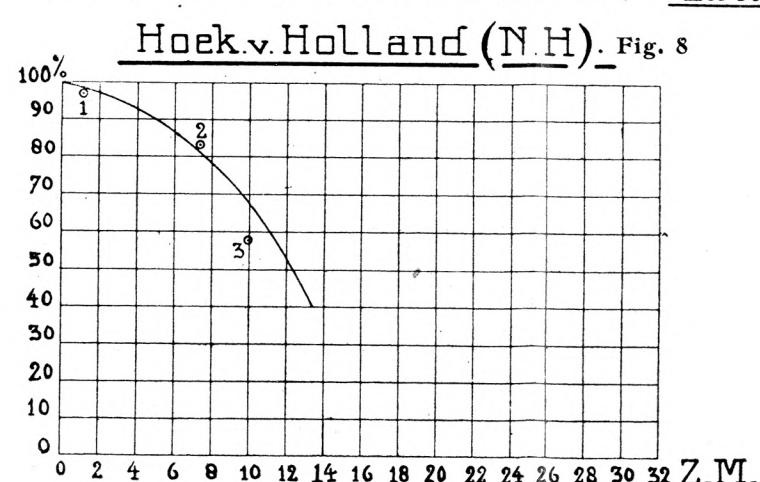


Fig. 8

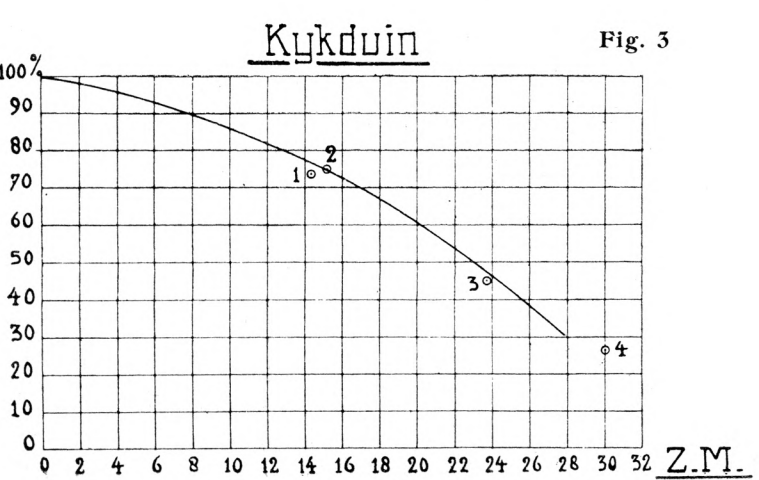


Fig. 5

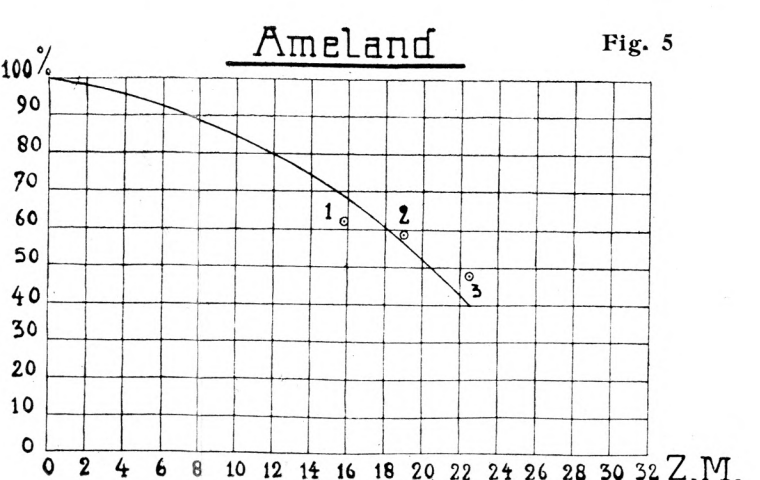


Fig. 5

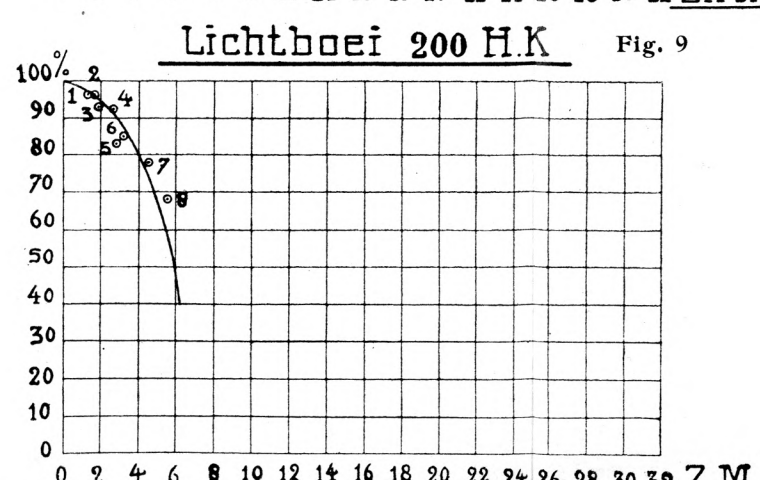


Fig. 9