DESCRIPTION AND PLANS

OF

LIGHTS FOR LIGHTHOUSES,

ACCORDING TO THE CATADIOPTRIC SYSTEM

OF

AUGUSTIN FRESNEL,

AND THE

HOLOPHOTAL SYSTEM AND OTHER IMPROVEMENTS.

MANUFACTURED BY CHANCE BROTHERS AND Co.,

GLASS WORKS, NEAR BIRMINGHAM.

1855.

AN ACCOUNT

OF THE

CONSTRUCTION AND PRICES

OF

CATADIOPTRIC SEA-LIGHTS,

OPTICAL AND MECHANICAL PORTIONS.

Sea-Lights situated upon the coast, and intended to warn vessels approaching it of its proximity, should be so placed and combined, with reference to one another, as to indicate either the particular point of the coast on which they are established, and the route to be followed when they are perceived, or the entrance to a roadstead or port, or the direction of a strait or current. In the latter instances, lights of a less intense brilliancy, and which necessitate but trifling costs of maintenance, are sufficient.

The great Sea-Lights destined more especially to mark the different points of the coast for the Navy, Vessels from abroad, and Coasters, ought generally to be placed near the land. They should also be built at such distances from each other, that when, in ordinary weather, the one from which a vessel is sailing begins to disappear from sight, the other which the vessel is nearing should be visible.

It is evident how important it is for mariners, that, as they perceive but one light on approaching the coast, they should never be exposed to the risk of being mistaken, and of taking the light they have in view for one of those nearest to it. To guard against this danger, it was necessary to distinguish, by a difference in appearance, all lights which happened to be situated within a certain distance of each other.

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AGENTS: Henry Struthers & Co. New York

1855.

A great number of experiments have been made in order to diversify the appearance of the lights; but, even at the present day, the combinations obtained are very limited. The parabolic mirrors of the old system offered few resources, and almost the only plan was to vary the time occupied by the different systems of lights in their revolutions, by augmenting and diminishing the number of flashes and eclipses in a certain given period, or by interposing coloured glasses, which lessened by one-half the intensity of the light. It is to the inefficiency of this system that we owe the researches of MONSIEUR A. FRESNEL, who, struck by the feebleness of our best parabolic lights, hit upon the expedient of Lenticular glasses, which he adapted with such satisfactory results both as regards the superiority of the light and saving of the fuel.

The experience of both English and Foreign mariners has set the advantages of this system beyond doubt, and proved how greatly it is preferable to every other.

This new system enables us to give to different lights of the same order, a difference in appearance, sufficiently marked to obviate all fear of mistake on the part of the mariner. For instance, if four lights were to be established on the same line of coast, the first would be, a light with flashes at intervals of a minute between each; the second, a light with short flashes; the third, a light with flashes at intervals of a half minute; and the fourth, a fixed light.

The lights being placed relatively to each other, in proportion to their average range in fair weather, which is of from ten to twelve leagues, of 20 to a degree, the distance between two neighbouring lights would be 20 leagues; and that between two lights of similar appearance, about 80 leagues. This is more than double the distance which could result from any error in reckoning the course of a ship, even after boisterous weather or a storm.

The necessities of Navigation require six kinds of lights, differing from one another in intensity, and classified as follows:—

Lights of the 1st order, Catadioptric.
Lights of the 2nd order, Catadioptric.
Lights of the 3rd order, Catadioptric.
Lights of the 4th order, Catadioptric (harbour lights).
Lights of the 5th order, Catadioptric (harbour lights).
Lights of the 6th order, Catadioptric (harbour lights).

Catoptric lights were used previous to the contrivance of Catadioptric lights. The Catadioptric lights possess an advantage of 16½ per cent. in intensity over those which are Catoptric. This fact was proved by MONS. ~~AUGUSTIN~~ Léonor FRESNEL on the occasion of his photometric experiments at the Observatory of Paris, on the 28th December, 1843, in the presence of Messrs. ARAGO and MATHIEU.

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In the Catoptric system, two sets of mirrors are introduced, so as to reflect such rays of the lamp as would pass over or under the intermediate dioptric cylinder.

In the Catadioptric system, these sets of mirrors are suppressed; a Catadioptric cupola of thirteen prismatic rings for the upper set of mirrors, and a cylindrical system of six Catadioptric rings for the lower set being substituted for the First Order.

The range of the Catadioptric Lights depends entirely upon the height at which they are placed above the level of the sea. The number of miles mentioned for each Order of Light is the average range at the ordinary elevation; but the sphericity of the surface of the sea is the practical limit to their range, which otherwise would be three or four times as great as the average stated.

For the description & prices of the revolving apparatus, according to the Holophotal system, see page 41 of the following pages.

SEA-LIGHTS OF THE FIRST ORDER.

THE Sea-lights of the 1st order are intended to mark the more advanced headlands, or indicate the more prominent points of the coast, as well as anchorages, to vessels coming from the offing. These lights present different appearances, and are designated as follows:—

FIXED LIGHT, presenting an equal distribution of light on all parts of the horizon.

LIGHT WITH SHORT ECLIPSES, presenting the characteristics of a Fixed light, varied every two minutes and forty seconds by flashes, preceded and followed by short eclipses.

REVOLVING LIGHT, presenting alternate flashes and eclipses at intervals of a minute, a half minute, or at any various interval of time as may be required.

All Sea-lights of the 1st order are lighted by means of a lamp with a burner of four concentric wicks. The oil is raised by a very simple contrivance, in sufficient quantity to feed the flames, and to allow an overflow to refresh the edges of the burner.

The Lantern in which lights of the 1st order are placed, should have an internal diameter of twelve to fourteen feet, with windows ten feet in height. The Lantern is constructed of iron, or iron covered with gun metal, or gun metal altogether. All the exterior surface, which is exposed to the sea air, is of copper. The roof or cupola which covers the Lantern is composed of sheets of rolled red copper, which are held fast by copper screws. The frame-work for the glass is made of metal, and is glazed with plate glass at least 3-8ths of an inch in thickness.

A gallery of metal plates supported upon brackets, for the use of the officials, runs round the iron platform on which the Lantern is placed, in order to facilitate the cleansing of the exterior of the apparatus, and also of the inside of the panes of the Lantern. There are curtains in the lantern, from east to west, to prevent the rays of the sun, which would penetrate the panels, from injuring the lamp placed in the middle of the apparatus, or from setting fire to the combustible objects which might be situated in the focus of the panels.

FIXED CATADIOPTRIC LIGHTS OF THE FIRST ORDER.

THE average range of these lights is twenty miles. They are composed of:
Eight Lenticular Panels, forming a cylinder, in the centre of which the lamp is placed.
Eight Catadioptric Panels, in the shape of a cupola, placed above the Lenticular cylinder.
Eight Catadioptric Panels, placed below the Lenticular cylinder.

The whole apparatus stands upon a fixed frame, placed on a cast-iron column.

PRICE OF A FIXED CATADIOPTRIC LIGHT OF THE FIRST ORDER.

Optical Portion ...	Eight cylindrical lenticular panels at £56.	...£448.0.0
	8 Catadioptric portions, upper £60 and lower at £45	... 840.0.0
Lamps	Three four-wick lamps, with accessaries	... 84.0.0
Frame	One fixed frame, with accessaries	160.0.0
Lantern	One lantern and accessaries (see pages 44 32)	880.0.0
Different Appurtenances.	Different appurtenances One hundred and fifty glass chimnies ... 130 ... feet of wicks, of each of the 4 Nos. ... ... Tin-work, brushes, shamoy leathers, polishing powder, utensils, and tools	48.0.0
	Total...	2460.0.0

Note.—If the light is only intended to illuminate part of the horizon, a certain number of Lenticular panels can be replaced, on the side looking towards the land, by the same number of spherically curved foil reflectors, the price of which is

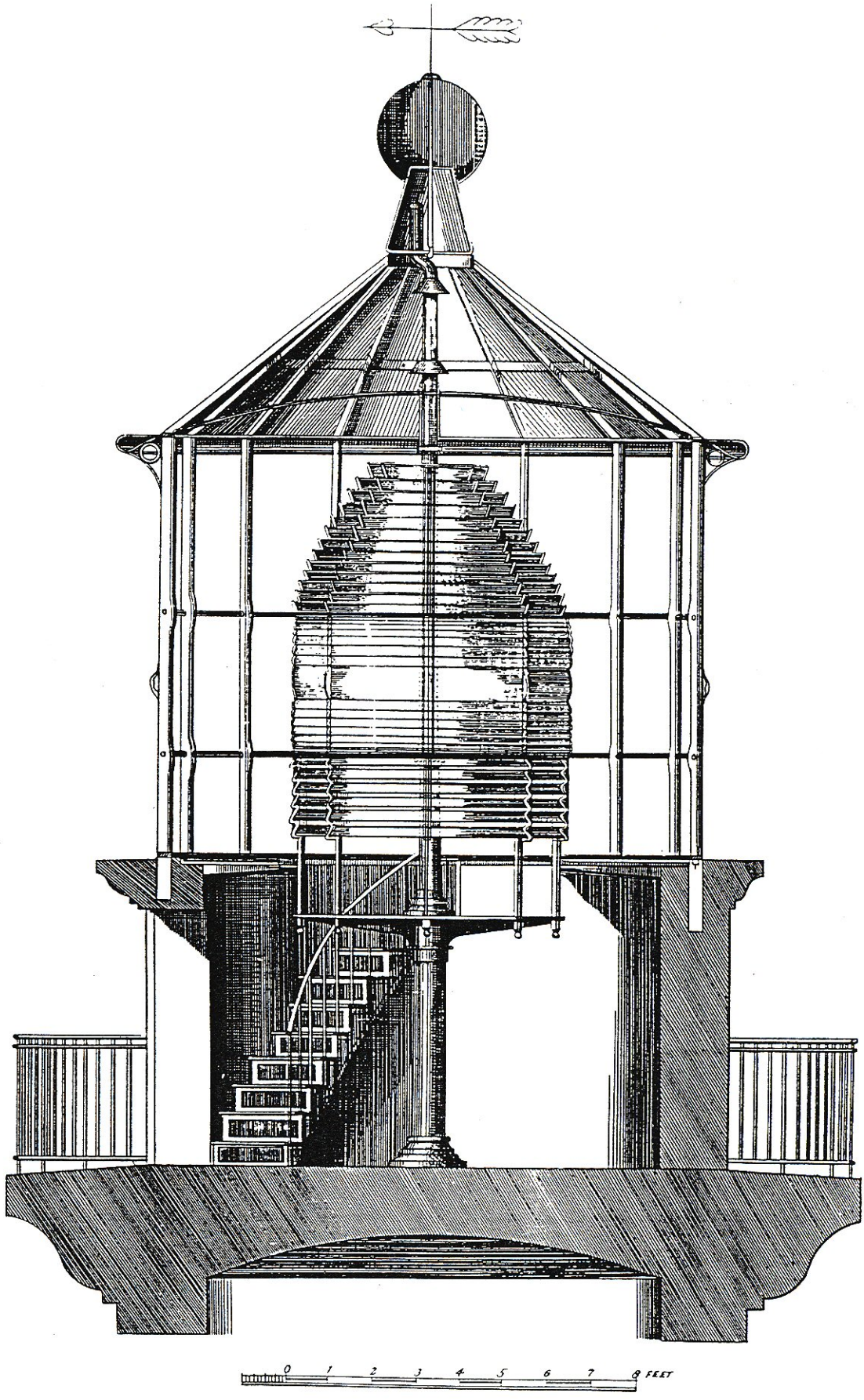
The average range of these lights is twenty miles.

Packing in double Cases of the apparatus ... £28.-
do ... do. of the Lantern Accessaries ... £28.-
Carriage to Liverpool or London of the apparatus. £8.-
do ..... do ..... of the Lantern ... £20.-

See General Observations page 16 & 32.

FIXED CATADIOPTRIC LIGHT OF THE FIRST ORDER,

Upon the System of Fresnel.



CATADIOPTRIC SEA-LIGHTS OF THE FIRST ORDER,

WITH SHORT ECLIPSES OR FLASHING LIGHTS.

THE average range of these lights is twenty-two miles.

They are composed of two portions, the one Fixed, the other Revolving. The fixed portion is composed of exactly the same parts as the fixed lights just described. The revolving portion is composed of three equidistant cylindrical panels, similar to those of the fixed light, but the curves of which are placed in a horizontal instead of a vertical position, so that in passing before the panels of the fixed light, they each produce, by their interposition, a similar effect to that of the spherical or annulary panels, that is, they diminish the divergence of the horizontal rays and unite them into a cone of light, so as to produce a most brilliant effect in passing before the eye of the observer. It is evident however, that this augmentation of light can only be obtained at the expense of that which illuminated the neighbouring parts, and that, consequently, this burst of light is preceded and followed by a short eclipse.

These three panels are secured in a metal frame, the motion of which is regulated by a rotary machine, which causes it to revolve round the fixed apparatus once every twelve minutes, or in any other given time.

The sea-lights with short eclipses have been lately made in an improved manner, viz:—

All the middle portion revolves, and consists, for the First Order, of eight panels, four of which are annular and four cylindrical. They are alternated, and, of course, produce the same effect as in the system above described, but more simply and with a greater intensity of light.

The proportion of these annular and cylindrical panels may be altered according to the number of flashes required in each revolution.

PRICE OF A CATADIOPTRIC SEA-LIGHT OF THE FIRST ORDER,

WITH SHORT ECLIPSES.

Optical Portion ...	Eight lenticular, cylindrical, and fixed panels	at £56-448-0-0	
	Three revolving panels at £16 ... at £45	..50. 150. 0. 0	
	Catadioptric portions, top and bottom	840. 0. 0	
Lamps	Three four-wick lamps	84. 0. 0	
Frames	Two frames, one fixed, and one revolving, with their accessaries	230. 0. 0	
Rotatory Machine ...	One rotatory machine, with its accessaries	125. 0. 0	
Lantern	One lantern, with its accessaries (see page 4.4.32) ...	880. 0. 0	
Sundry Fittings ...	Fittings and accessary expenses ... ... One hundred and fifty glass chimnies, 120 feet of wicks, of each of the 4 Nos., tin-work, brushes, shamoy leather, polishing powder, utensils, tools, &c....	48. 0. 0	
	Total...	2808. 0. 0	

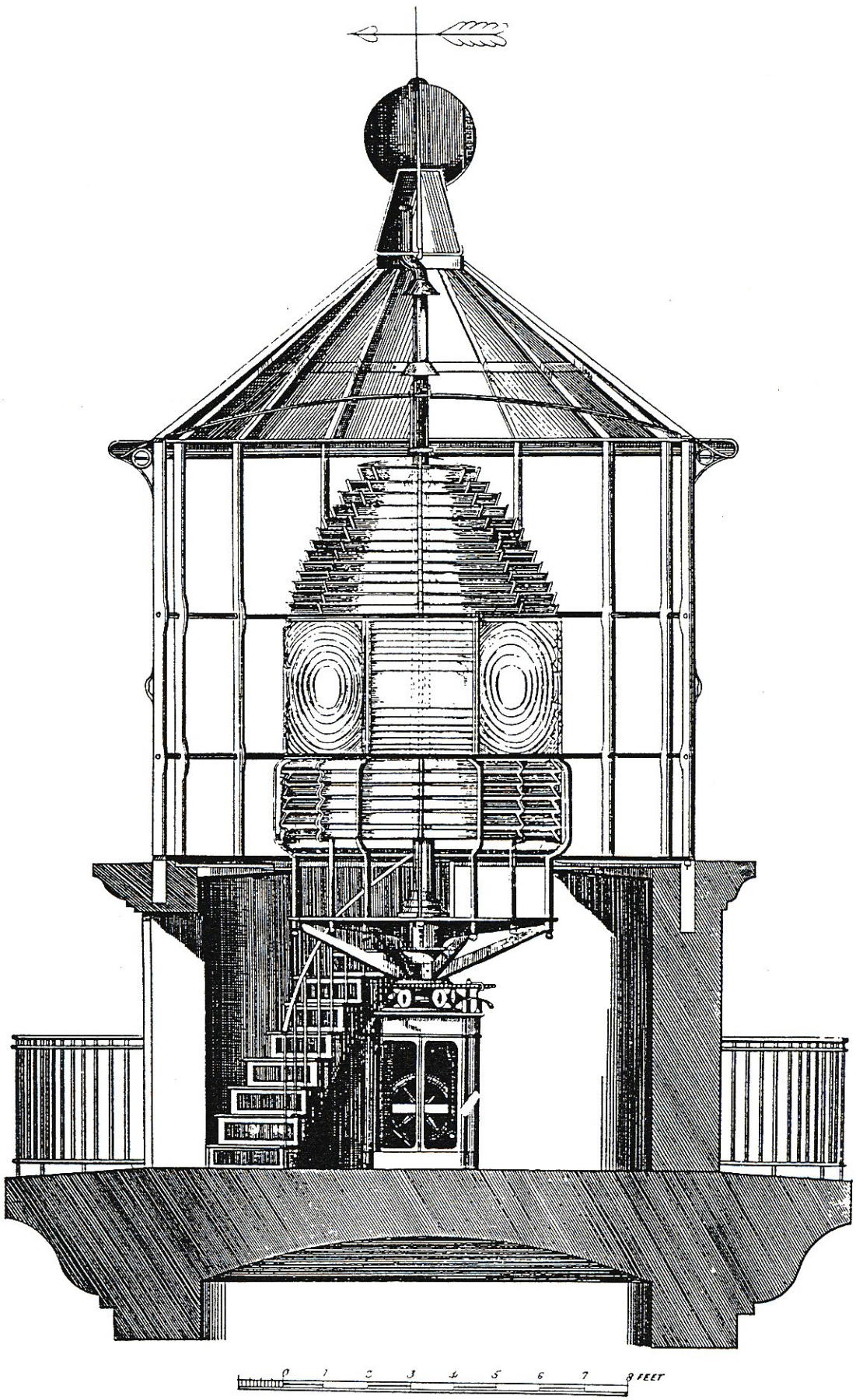
The average range of these lights is twenty-two miles.

Packing in Double Cases of the Apparatus £32.
do. of the Lantern & accessaries ..... 28.
Carriage to Liverpool or London of the Apparatus £10-
..do..... do. of the Lantern 20-

See General observations page 16 & 32.

REVOLVING CATADIOPTRIC LIGHT OF THE FIRST ORDER,

With Short Eclipses. (Improved arrangement.)



PRICE OF A CATADIOPTRIC SEA-LIGHT OF THE FIRST ORDER,

WITH SHORT ECLIPSES.

(IMPROVED ARRANGEMENT.)

Optical Portion ...	4 cylindrical panels at £56 ...	£224 ...	1296.0.0
	4 annular panels ... at £58 ...	232 ...	
	8 Catadioptric portions, top (at £60) and bottom (at £45) ...	840 ...	
Lamps	Three four-wick lamps		84.0.0
Frames	Two frames, one fixed and one revolving, with their accessaries		230.0.0
Rotatory Machine ...	One rotatory machine, with its accessaries		128.0.0
Lantern	One lantern, with its accessaries (see pages 4 & 32) ...		880.0.0
Sundry Fittings. ...	Fittings, and accessary expenses ... ... One hundred and fifty glass chimnies, 120 feet of wicks, of each of the 4 Nos., tin-work, brushes, shamoy leather, polishing powder, utensils, tools, &c.		48.0.0
		Total ...	2666.0.0

The average range of these lights is twenty-two miles.

Packing in double Cases of the apparatus £32.0
do .... " ..... of the Lantern & accessories .. £28.0

Carriage to Liverpool or London of the apparatus £10 –
do —— do — of the Lantern — £20 —

See General Observations pages 16 & 32

REVOLVING LIGHTS,

WITH ECLIPSES AT INTERVALS OF A MINUTE.

THE average range of these lights is thirty-three miles.

They are composed of—

Eight annular panels, with a focus of $36\frac{1}{4}$ inches; $39\frac{1}{2}$ inches in height, and $30\frac{1}{2}$ inches in breadth, forming a polygon, in the centre of which the lamp is placed.

These eight panels are placed upon a moveable frame, which a rotatory machine causes to describe a complete revolution once in every eight minutes.

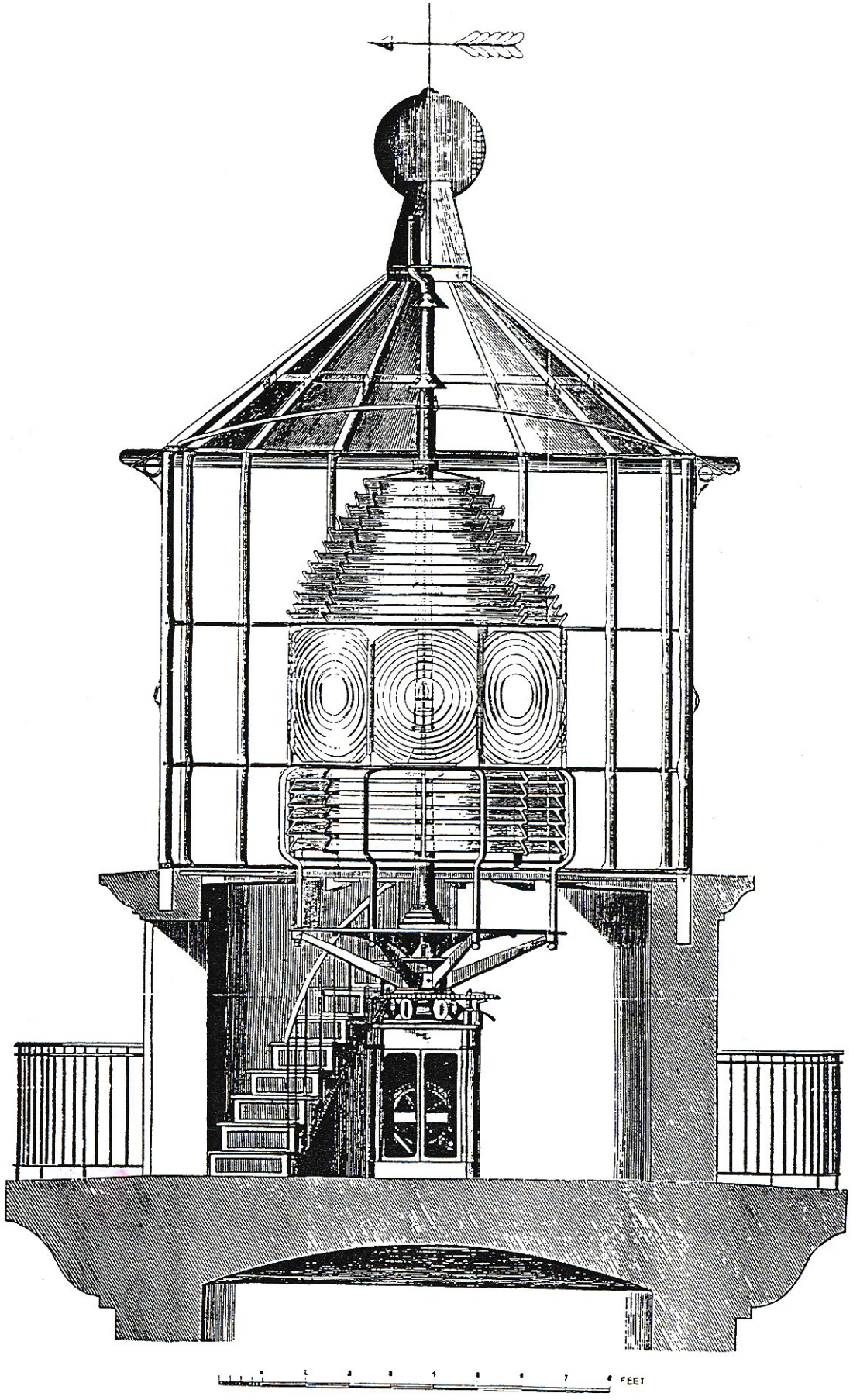
The moveable frame is so arranged as to allow another frame, which is immoveable, to be placed within it. The latter frame comprises the following parts:—

Eight Catadioptric panels in the shape of a cupola placed over the polygon.

A cylindrical system of six Catadioptric rings placed beneath the polygon.

The whole rests upon a metal column.

CATADIOPTRIC LIGHT OF THE FIRST ORDER, UPON THE SYSTEM OF FRESNEL.



0 1 2 3 4 5 6 7 8 FEET

PRICE OF A LIGHT OF THE FIRST ORDER,

WITH ECLIPSES AT INTERVALS OF A MINUTE.

Optical Portion ...	Eight annular panels at ~~£58~~ ...	£464	
	Upper Catadioptric portion 8 panels at £60 ...	480	
	Lower Catadioptric portion 8 panels at £45 ...	360	1304. 0. 0
Lamps	Three four-wick lamps		84. 0. 0
Frames	Two frames, and their accessaries		230. 0. 0
Rotatory Machine ...	One rotatory machine		128. 0. 0
Lantern	One lantern, and its accessaries. (See page 48.32) ...		880. 0. 0
Various Appurtenances.	Appurtenances, and accessary expenses, ...		
	One hundred and fifty glass chimnies, 130 feet of wicks, of each of the 4 Nos., tin-work, brushes, shamoy leather, polishing powder, tools, &c.		48. 0. 0
		Total...	2674. 0. 0

The average range of these lights is thirty-three miles.

Packing in Double Cases of the Apparatus ..... £32.
do ... do. of the Lantern & accessaries ..... £28.
Carriage to Liverpool or London of the apparatus £10
do ..... do London of the Lantern. £20.—

See Ground Observations pages 16 & 32.

REVOLVING LIGHTS,

WITH ECLIPSES AT INTERVALS OF A HALF MINUTE.

THE average range of these lights is twenty-seven miles.

They are composed of—

Sixteen half panels (annular) of a focus of $36\frac{1}{4}$ inches; $39\frac{1}{2}$ in height, and $14\frac{3}{4}$ inches in breadth, forming a polygon.

A moveable iron frame on which these sixteen half panels are placed.

This frame is moved by a rotatory machine, which causes it to describe a complete revolution every eight minutes.

Eight Catadioptric panels in the shape of a cupola placed over the polygon.

A cylindrical system of six Catadioptric rings, placed beneath the polygon.

The whole is placed upon a metal column.

PRICE OF A LIGHT OF THE FIRST ORDER,

WITH ECLIPSES AT INTERVALS OF A HALF MINUTE.

Optical Portion ...	Sixteen half panels (annular) at £28 ...	£448.	
	Upper Catadioptric portion 8 panels at 60	£480.	
	Lower Catadioptric portion 8 panels at £45	360	1288. 0. 0
Lamps	Three four-wick lamps		84. 0. 0
Frames	Two frames and their accessaries		230. 0. 0
Rotatory Machine	One rotatory machine		125. 0. 0
Lantern	One lantern with its accessaries ... (See page 4 £32)		880. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses— One hundred and fifty glass chimnies, 120 set of wicks of each of the 4 Nos., tin-work, brushes, shamoy leathers, polishing powder, utensils, tools, &c.	—	48. 0. 0
	Total...		2,658. 0. 0

The average range is twenty-seven miles.

Packing in double Cases of the Apparatus £32.
do ..... do of the Lantern Accessaries £28.
Carriage to Liverpool or London of the Apparatus £10.
do ..... do ..... of the Lantern ... £20.

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See General Observations Pages 16 & 32.

MIXT APPARATUS OF THE FIRST ORDER.

Sea-Lights of the First Order, with Eclipses at intervals of a minute and at intervals of a half minute, were once made in a different manner.

In place of the upper Catadioptric portion, a combined system of eight lenses and plane mirrors was used. Economy in the first outlay could now be the only reason of adopting such an arrangement, inasmuch as the intensity of light of the present upper portion is sixteen per cent. stronger than that of the old one.

The average range was respectively twenty-six and twenty-four miles, for the lights with Eclipses at intervals of a minute and at intervals of a half minute.

PRICE OF A LIGHT OF THE FIRST ORDER,

WITH ECLIPSES AT INTERVALS OF A MINUTE.

(OLD ARRANGEMENT.)

Optical Portion ...	Eight annular panels ~~at £58~~	464. 0. 0
	Eight pyramidical lenses and their plane mirrors ...	116. 16. 0
	Lower Catadioptric portion 8 Panels at £45 ...	360. 0. 0
Lamps	Three four-wick lamps	84. 0. 0
Frames	Two frames, and their accessaries	230. 0. 0
Rotatory Machine ...	One rotatory machine	128. 0. 0
Lantern	One lantern, and its accessaries (see pages 44 & 52) ...	880. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses:— One hundred and fifty glass chimnies, £30 1 cwt of wicks, of each of the 4 Nos., tin-work, brushes, shamoy leather, polishing powder, tools, &c.	48. 0. 0
	Total...	2310. 16. 0

The average range of these lights is twenty-six miles.

Packing in double Cases of the Apparatus £32.
do ..... " of the Lantern & accessaries ... £28.

Carriage to Liverpool or London of the Apparatus £10.
do ..... " of the Lantern £20

See General Observations pages 16 & 32.

PRICE OF A LIGHT OF THE FIRST ORDER,

WITH ECLIPSES AT INTERVALS OF A HALF MINUTE.

(OLD ARRANGEMENT.)

Optical Portion ...	Sixteen half panels (annular) ..at £28 ...	448. 0. 0
	Eight pyramidical lenses and their plane mirrors...	116. 16. 0
	Lower Catadioptric portion 8 panels at £45...	360. 0. 0
Lamps	Three four-wick lamps	84. 0. 0
Frames	Two frames, and their accessaries	230. 0. 0
Rotatory Machine ...	One rotatory machine	128. 0. 0
Lantern	One lantern with its accessaries. (See pages 31 & 32)	880. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses,— One hundred and fifty glass chimnies ... 130 ... Set of wicks, of each of the 4 Nos. ... ... Tin-work, brushes, shamoy leathers, polishing powder, utensils, tools, &c.	48. 0. 0
	Total...	2294. 16. 0

The average range of these lights is twenty-four miles.

Packing in double Cases of the Apparatus £32.
do. do. of the Lantern & accessaries. £28
Carriage to Liverpool or London of the Apparatus £10
do. .... do. of the Lantern .. £20

See General Observations Pages 16 & 32.

The foregoing prices of the Optical portions of the First Order Lights apply to apparatus of which the Catadioptric portions are composed of 13 Zones of prisms in the upper part, and of 6 Zones in the lower part.

ANNUAL COST OF A SEA-LIGHT OF THE FIRST ORDER.

Of Rape Seed Oil, ± 7000 lbs (.02750 grammes per hour)	
Wicks and glass chimnies	
Linen, spirits of wine, polishing powder, putty, &c.	
Maintenance of lamps and cords of rotatory machine	
Ditto windows of lantern, and painting them	
Ditto appurtenances	
Salary of the two keepers	
,, head keeper	
,, second keeper...	
Firing for keepers	
Expense of superintendence	
Total...	

The annual cost above specified is the same for all Sea-lights of the First Order, whatever may be their difference.

SEA-LIGHTS OF THE SECOND ORDER.

INTERNAL DIAMETER, 4 FEET 7 INCHES.

THE lights of the Second Order ought generally to be placed at the mouths of large rivers or on shoals surrounded by shallows.

They are capable of presenting the same appearances as Sea-lights of the First Order.

They are lighted by a lamp with three concentric wicks.

This lamp, which is of smaller dimensions than those of lights of the First Order, is constructed on the same principle.

FIXED CATADIOPTRIC LIGHTS OF THE SECOND ORDER.

INTERNAL DIAMETER, 4 FEET 7 INCHES.

THE average range of these lights is sixteen miles. They are composed of:—

Six panels of a focus of 27½ inches, forming a Lenticular cylinder of 4 feet 7 inches in diameter, in the centre of which the lamp is placed.

Six Catadioptric panels, in the shape of a cupola, placed above the Lenticular cylinder.

Five Catadioptric panels placed beneath the Lenticular cylinder.

The whole is fixed upon an iron frame placed on a metal column.

PRICE OF A CATADIOPTRIC FIXED LIGHT OF THE SECOND ORDER.

Optical Portion ...	Six cylindrical panels at £48. ...	£288...	
	6 Catadioptric portions upper and lower at £82 at £31.8/- ...	500..8/-	788. 8. 0
Lamps	Three ~~four~~-wick lamps, and their accessaries		75. 12. 0
Frame	One fixed frame, and its accessaries		126. 0. 0
Lantern	One lantern, and its accessaries ... (see pages 4 & 32.)		600. 0. 0
Various Appurtenances.	Various appurtenances		36. 0. 0
	One hundred and fifty glass chimnies		

Total... 1626. 0. 0

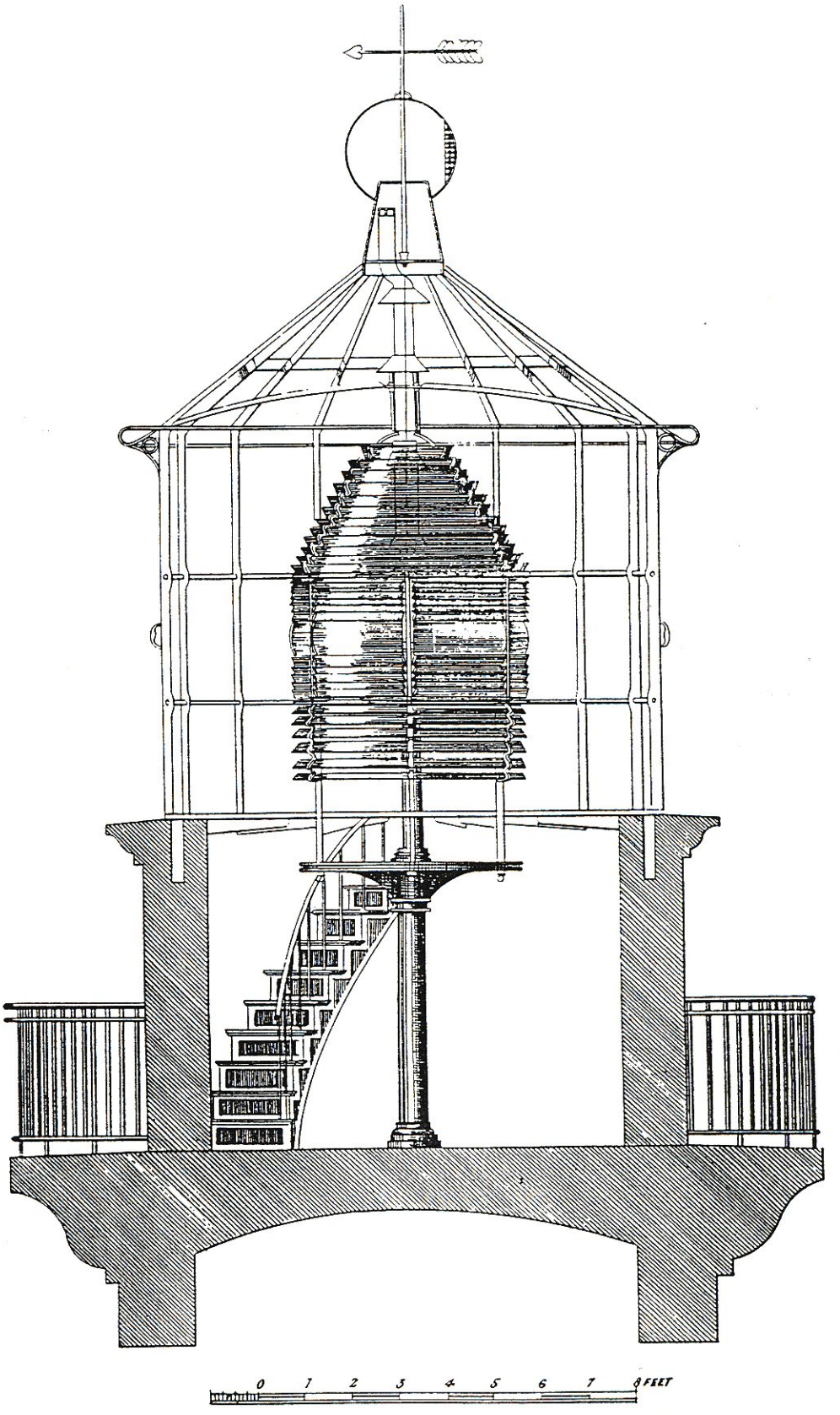
Same remark as for Fixed Lights of the First Order.

The average range of these lights is sixteen miles.

Packing the apparatus in double Boxes £18.
" ... the Lantern & accessaries &c... £18.
Carriage to London Liverpool - apparatus £7.
do. do. do. Lantern & accessaries .. £16.—

See General observations page 32.

FIXED CATADIOPTRIC LIGHT OF THE SECOND ORDER



CATADIOPTRIC LIGHTS OF THE SECOND ORDER,

WITH SHORT ECLIPSES.

THE average range of these lights is nineteen miles.

They are composed of two portions, the one Fixed, and the other Revolving. The fixed portion is composed of exactly the same parts as the fixed light just described, and the revolving part is the same, only smaller, as that of the light of the First Order with short eclipses.

The improved system, as described for the lights of the First Order, with short flashes, is likewise adapted to this order.

PRICE OF A CATADIOPTRIC LIGHT OF THE SECOND ORDER,

WITH SHORT ECLIPSES.

(Old Arrangement)

Optical Portion ...	Six Lenticular cylindrical panels, fixed at £48	£288	
	Three ditto moveable at £40	120.	
	6 Catadioptric portions, upper £52 and lower 31.8	500.8/	908. 8. 0
Lamps	Three three-wick lamps		75.12.—
Frames	Two frames, one fixed and one revolving		176. —
Rotatory Machine ...	One rotatory machine		124 —
Lantern	One lantern, and its accessaries (see pages 4 & 32.)		600. —
Various Appurtenances	Appurtenances and accessary expenses		
	One hundred and fifty glass chimnies		36. — —

Total... £1920. 0. 0

Same remark as for a Fixed light of the First Order.

The average range of these lights is nineteen miles.

Packing of the Apparatus in double Boxes £22—
" of the Lantern & accessaries — " — £18.—
Carriage to London or Liverpool — Apparatus — £9—
Do — do — Lantern &c — £16.—

See general observations page 32.

PRICE OF A CATADIOPTRIC LIGHT OF THE SECOND ORDER,

WITH SHORT ECLIPSES.

(IMPROVED ARRANGEMENT.)

Optical Portion ...	3 cylindrical panels	at £48.	£144.0	
	3 annular panels	at £48.	144.0	
	6 Catadioptric portions, upper and lower	£52 31.8	500.8	788. 8. 0
Lamps	Three three-wick lamps			75. 12. —
Frames	Two frames, one fixed and one revolving			136. —. —
Rotatory Machine ...	One rotatory machine			124. —. —
Lantern	One lantern, and its accessaries (see page 4.132) ...			600. —. —
Various Appurtenances.	Appurtenances and accessary expenses			36. 0. 0
	One hundred and fifty glass chimnies			
	Total...			1800. 0. 0

Same remark as for a Fixed light of the First Order.

The average range of these lights is nineteen miles.

N.B.—See note, page 7, respecting the number of cylindrical and annular panels.

Packing in double cases of the apparatus ..... £22—
do .... do. of the lantern accessories ... £18.—
Carriage to London or Liverpool of the apparatus .. £19.—
" .... " .... of the Lantern .... £16—

See General Observations page 32.

REVOLVING LIGHTS OF THE SECOND ORDER,

WITH ECLIPSES AT INTERVALS OF A MINUTE.

THE average range of these lights is twenty miles. They are composed of:—

Eight annular panels of $32\frac{1}{4}$ inches in height, $23\frac{1}{4}$ inches in breadth, and a focus of $27\frac{1}{2}$ inches, forming a polygon, in the centre of which the lamp is placed.

These eight panels are arranged upon a moveable frame, which is made, by a rotatory machine, to describe a complete revolution in eight minutes.

The arrangement of this frame is of such a nature as to allow a fixed frame to be placed within it. This latter contains the following objects:—

Catadioptric panels in the form of a cupola, placed above the polygon.

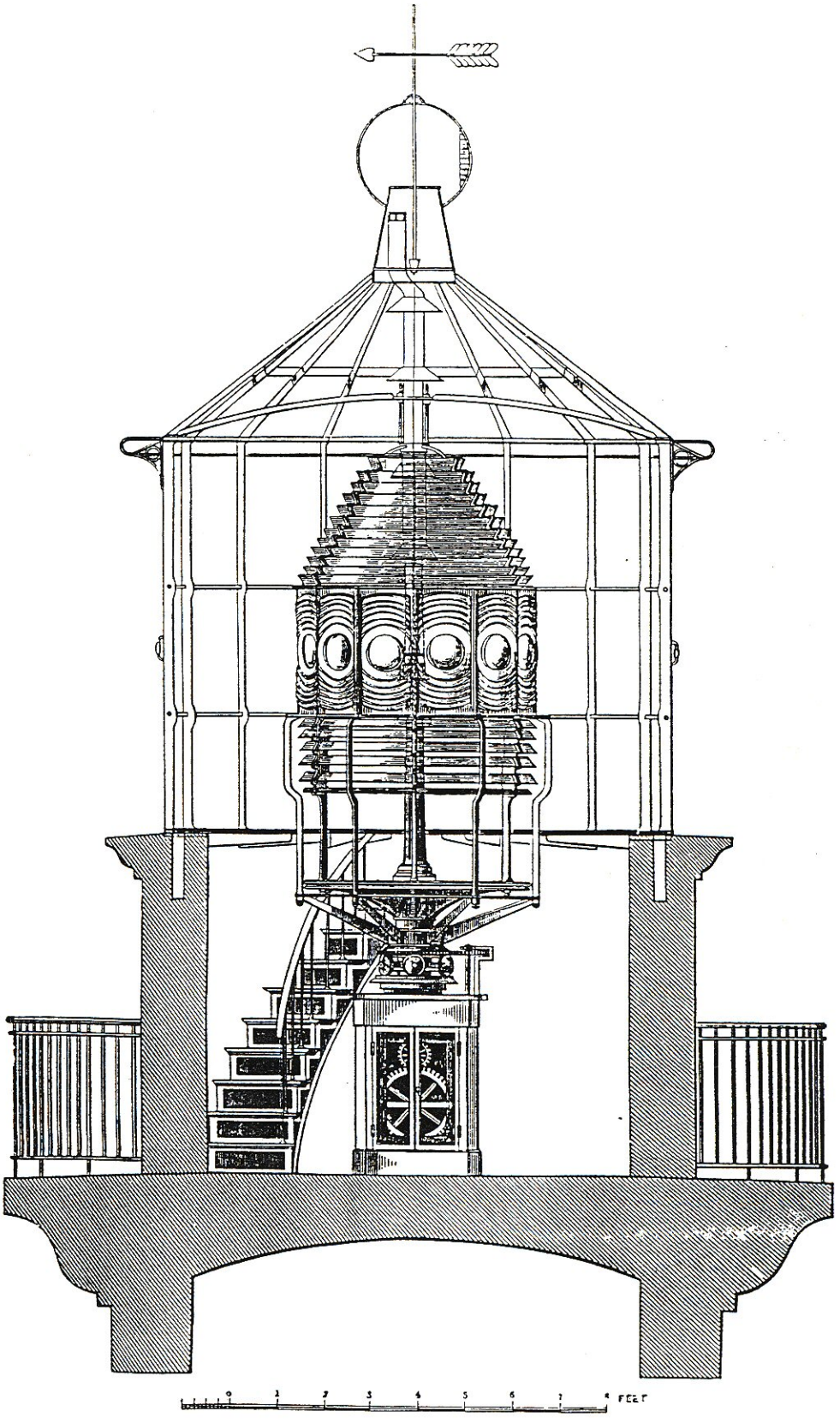
A cylindrical system of six Catadioptric rings placed below the polygon.

The whole rests upon a metal column, or the rotatory machine.

In some cases six annular lenses only are used instead of eight.

CATADIOPTRIC LIGHT OF THE SECOND ORDER, UPON THE SYSTEM OF FRESNEL.

With Eclipses at intervals of half-a-minute.



PRICE OF A LIGHT OF THE SECOND ORDER,

WITH ECLIPSES AT INTERVALS OF A MINUTE.

Optical Portion	6 Eight annular panels at £48	£...288...	
	6 Catadioptric portions, upper and lower at £52 at 31.8/	...500..8/-	788. 8. 0
Lamps	Three three-wick lamps,...		75. 12. 0
Frames	Two frames, one fixed, and one revolving		176. 0. 0
Rotatory Machine ...	One rotatory machine		124. 0. 0
Lantern	One lantern, with its accessaries (see page 4.432.../		600. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses		36. 0. 0
	One hundred and fifty glass chimnies		
	Total...		1800. 0. 0

Same remark as for Fixed Lights of the First Order.

The average range of these lights is twenty miles.

Packing of the apparatus in Double Cases £22.
do of Lantern & Accessaries do.. £18.
Carriage to London or Liverpool of the apparatus £9.
do ..... of the Lantern ..... £16.

See General Observations Page 32.

PRICE OF A LIGHT OF THE SECOND ORDER,

WITH ECLIPSES AT INTERVALS OF A HALF MINUTE.

Optical Portion ...	Twelve annular panels ... (half (at £24 £288.	
	6 Catadioptric portions, at £52 upper and lower £31.8 ...	500. 8) 788. 8. 0
Lamps	Three three-wick lamps	75. 12. 0
Frames	Two frames, one fixed, and one revolving	176. 0. 0
Rotatory Machine ...	One rotatory machine	124. 0. 0
Lantern	One lantern, and its accessaries (see page 4 & 32) ...	600. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses	36. 0. 0

Total... £1,800. 0. 0

Same remarks as for fixed lights of the First Order.

The average range of these lights is nineteen miles.

Packing in double Cases of the Aparatus .... £22.
do....... do... of the Lantern & accessories . £18.
Carriage to London or Liverpool of the apparatus £9
do..... do. of the Lantern .... £16.

See General Observations page 32.

ANNUAL COST OF A LIGHT OF THE SECOND ORDER.

Of Rape Seed Oil, ~~at~~ 3500. lbs (for 500 grammes per hour) ... ...
Salary of two keepers ... ...
Wicks, and glass chimnies ... ...
Old rags, and polishing powder ... ...
Firing for keepers ... ...
Painting, and renewal of plate glass of lantern ... ...
Costs of keeping up fittings of lamps, and expenses of superintendence ... ...

Total...

LIGHTS OF THE THIRD ORDER.

INTERNAL DIAMETER 3 FEET $3\frac{1}{2}$ INCHES.

Lights of the Third Order generally serve to mark the mouths of rivers, the entrance of roadsteads, and ports or places of anchorage.

These lights cannot advantageously present the same varieties as the lights of the preceding orders. The number of their variations is restricted to the two following, viz:—

Fixed lights.

Lights with short eclipses.

They are lighted by a lamp with two concentric wicks, consuming 190 grammes of oil an hour: this lamp, which is smaller than those of the 2nd Order, is constructed on the same principle.

The lantern of these lights is 8 feet 4 inches in internal diameter, and the height of its windows is 6 feet.

FIXED CATADIOPTRIC LIGHTS OF THE THIRD ORDER.

The average range of these lights is fifteen miles. They are composed of:—

Four panels, 27 inches high, 23 inches broad, and with a focus of 19¾ inches, forming a Lenticular cylinder, in the centre of which is placed the lamp.

Two half panels, forming a door, to facilitate the necessary attendance on the lamp.

Five Catadioptric panels, in form of a cupola, placed above the cylinder.

PRICE OF A CATADIOPTRIC FIXED LIGHT OF THE THIRD ORDER.

Optical Portion	Four fixed cylindrical panels at £32.	£128	
	Two half panels as door... at £17..	34	
	Five Catadioptric panels ... at 29.12/-	148	310 . 0 . 0
Lamps	Three two-wick lamps, and their accessaries ...		50 . 0 . 0
Frame	One frame, and its accessaries		52 . 0 . 0
Lantern	One lantern and its accessaries (see page 432)		380 . 0 . 0
Various Appurtenances.	Appurtenances, and accessary expenses		24 . 0 . 0

Total... £816 . 0 . 0

The average range of these lights is fifteen miles.

Packing of the apparatus in Double Boxes £12.
do. of Lantern Accessaries ..... £14.
Carriage to Liverpool or London - apparatus £4.
do. ..... " ..... - Lantern .. £8.

See General Observations Page 32.

CATADIOPTRIC LIGHTS OF THE THIRD ORDER,

WITH SHORT ECLIPSES.

THE average range of these lights is sixteen miles.

They are composed of two parts, one Fixed, and the other Revolving. The fixed part is composed of exactly the same pieces as the fixed light mentioned before; the revolving part is the same, only smaller, as that of the light of the First Order with short eclipses.

PRICE OF A CATADIOPTRIC LIGHT OF THE THIRD ORDER,

WITH SHORT ECLIPSES.

Optical Portion ...	Four cylindrical panels at £32. ...	£128.	
	Two half panels, forming door £17 ...	34.	
	Three revolving cylindrical panels ... £26..	78.	
	Five Catadioptric panels, at 29.12/- forming a cupola ...	148	388. 0. 0
Lamps	Three two-wick lamps		50. 0. 0
Frames	Two frames, one fixed, one revolving, with their accessaries		104. 0. 0
Rotatory Machine	Rotatory machine, and its accessaries		80. 0. 0
Lantern	One lantern and its accessaries ... see page 4 & 32 ..		380. 0. 0
Various Appurtenances.			24. 0. 0
	Total...		£1026. 0. 0

The average range of these lights is sixteen miles.

Packing of the Apparatus in Double Boxes £16.
do of the Lantern Accessaries ... do £14.
Carriage to London or Liverpool — Apparatus £6.
do ... do ... ... Lantern £8.

See General Observations page 32

ANNUAL COST OF A LIGHT OF THE THIRD ORDER.

Of Rape Seed Oil, at 1700 lbs (or 190 hammers per hour)	
Salary of two keepers	
Wicks and glass chimnies	
Firing for keepers	
Old rags and polishing powder	
Painting and renewal of plate glass of the lantern	
Maintenance of several appurtenances of the lamp, and cost of superintendence	
Total...	

Prices of Fixed Lights of the Fourth Order, illuminating sections only of the horizon - viz^t

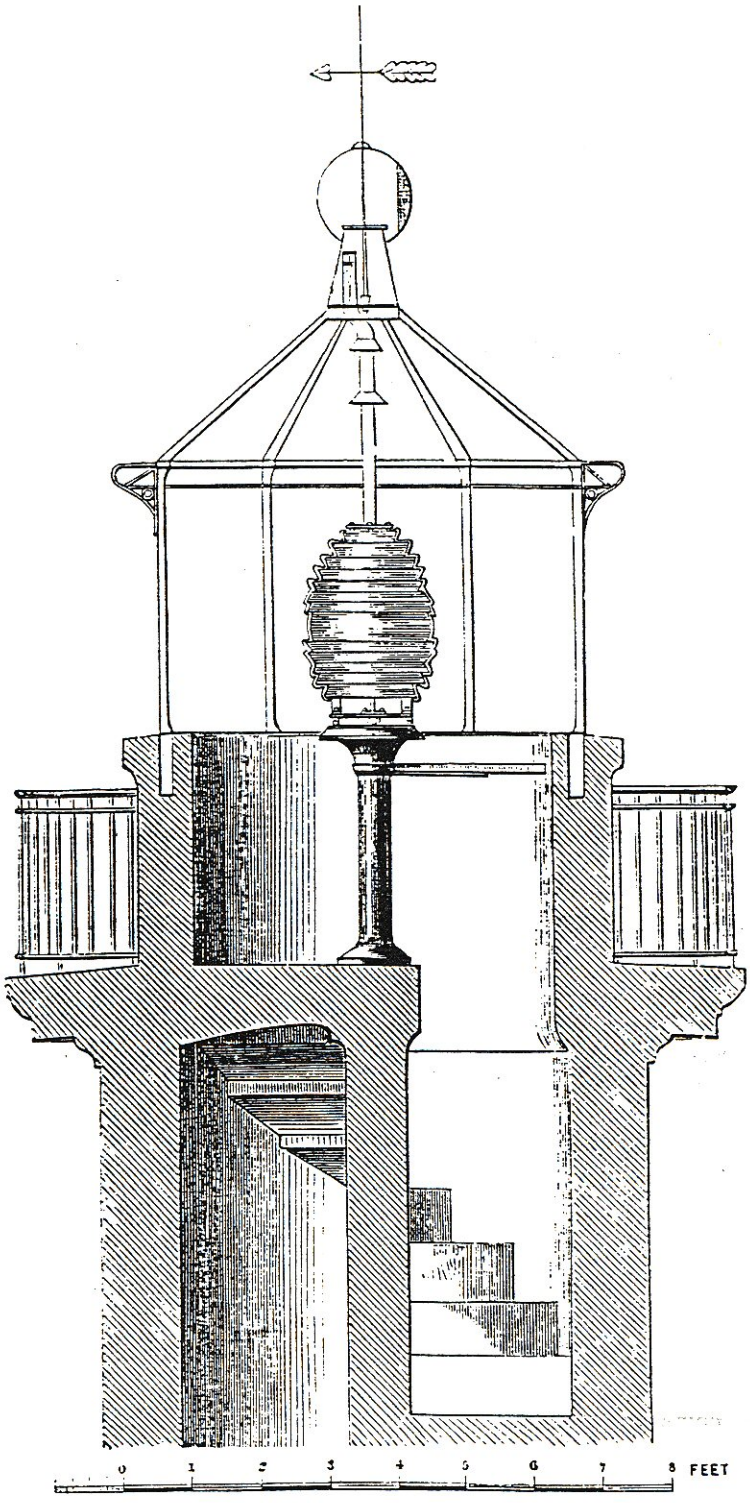
	270°	180°	90°
Frame 8.0.0 3 Lamps 12.0.0 Lantern 160.0.0 Sundries 16.0.0	£196.0.0	£196.0.0	£196.0.0
Plated Silver Reflectors	£4.0.0	£4.0.0	£8.0.0
Total	£292.0.0	£268.0.0	£244.0.0

Packing and Carriage, the same as for 360°.

See General observations page 39.

FIXED LIGHT OF THE FOURTH ORDER.

Upon Fresnel's System.



LIGHTS OF THE FOURTH, FIFTH, AND SIXTH ORDERS.

(HARBOUR LIGHTS.)

The lights of the Fourth, Fifth, and Sixth Orders are intended to mark the entrance to a port, or the direction of a strait or current.

These small apparatuses present only two kinds:—

Fixed lights.

Lights with short eclipses.

FIXED LIGHTS OF THE FOURTH ORDER.

INTERNAL DIAMETER $19\frac{5}{8}$ INCHES.

The range of these lights is twelve miles.

They are composed of a Lenticular cylinder, in the centre of which is the lamp.

Five Catadioptric prismatic rings, placed above the Lenticular cylinder.

Three Catadioptric prismatic rings, placed beneath the cylinder.

All these different parts are fixed on a brass frame.

PRICE OF A FIXED LIGHT OF THE FOURTH ORDER.

360°

Optical Portion ...	Apparatus illuminating the entire horizon, metal candelabrum, and accessary pieces...	£120. 0. 0
Frame	One frame, and accessaries	8. 0. 0
Lamps	Three lamps	12. 0. 0
Lantern	One lantern, and its accessaries ... See pages 4 & 39 ...	160. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses	16. 0. 0

Packing apparatus in Double Boxes £4.
do Lantern & accessaries .... £3.
Carriage to London & Liverpool - apparatus £2.
do " ..... do. Lantern £4

Total... 316. 0. 0

See General Observations p. 39.

LIGHTS OF THE FOURTH ORDER,

WITH SHORT ECLIPSES.

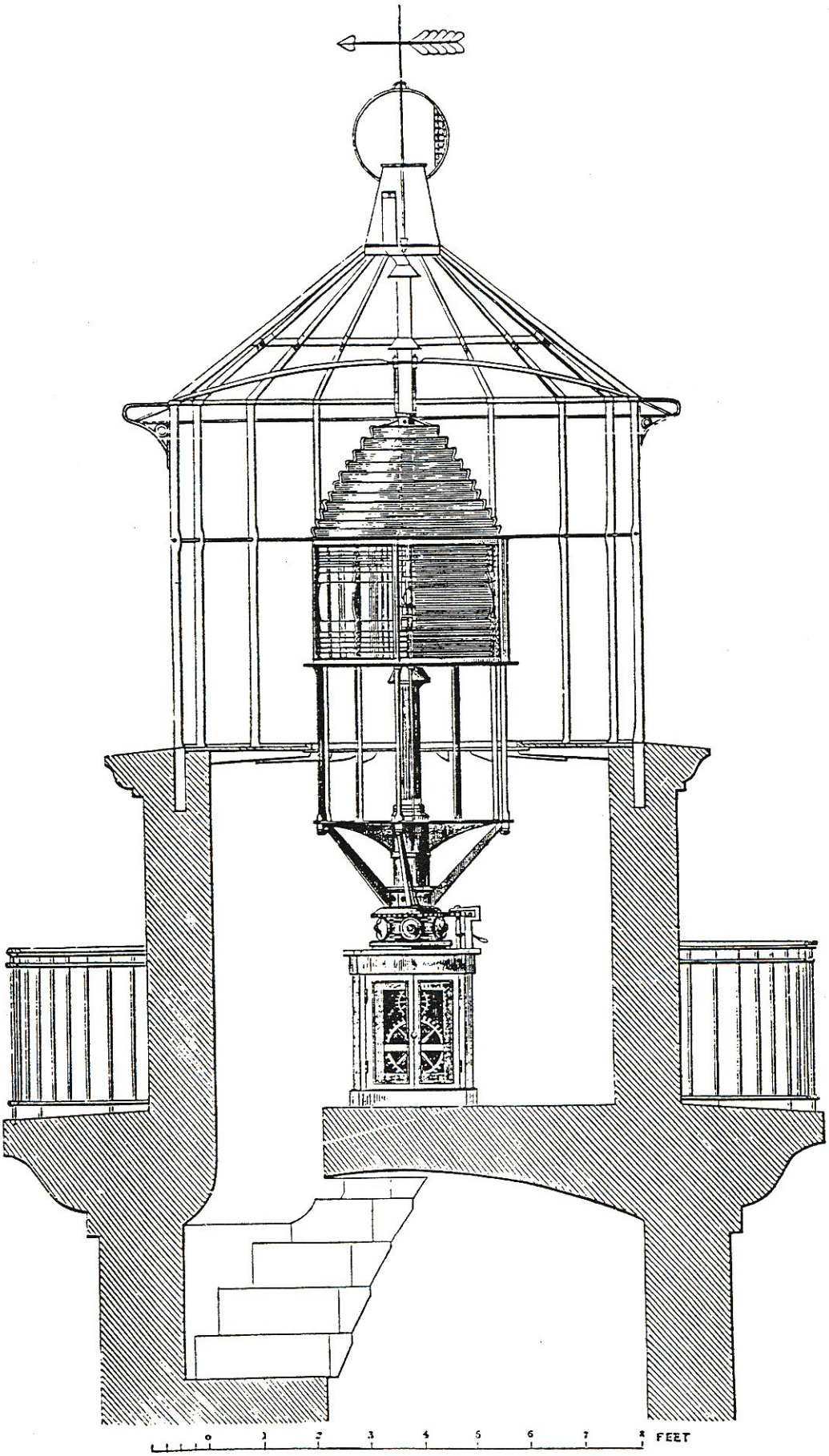
INTERNAL DIAMETER $19\frac{5}{8}$ INCHES.

THE average range of these lights is fifteen miles.

They are, like those of the preceding orders, composed of two parts, the one Fixed, and the other Revolving. The fixed part contains the same pieces as the fixed light above mentioned, and the revolving part is composed of two cylindrical panels, placed on a moveable frame, performing a revolution every six minutes.

CATADIOPTRIC LIGHT OF THE THIRD ORDER.

With Short Eclipses.



General Observations
on
First, Second & Third Order Lights of all Kinds

1°. In establishing the foregoing prices, we have assumed, for the sake of greater clearness, that the lower Catadioptric portions of different Lights are supplied complete, whereas one of those panels is generally suppressed to afford entrance into the Lights though this object may be attained by hanging one of these panels on hinges if desired. The suppression of one of these lower panels makes a difference in the prices of £45 & £31.8. for 1st & 2d order Lights respectively

2°. Fixed Lights are sometimes required to illuminate a portion only of the horizon, in which case one or more segments may be suppressed, for which the following reductions are made in the prices - viz

I In First Order Lights, which are composed of eight segments each of 45° - for every segment of 45° suppressed a reduction in the price of the Optical portion is made of (See page 6) ——— 161. —. —

but as it is necessary to replace each central lens suppressed, by a silver plated reflector, of which the cost is ——— ——— 17. —. —

the net reduction for one segment of 45° suppressed will be £ 144. —. —

II. In Second Order Lights, which are composed of two segments each 60° - for every segment of 60° suppressed the reduction in the price of the Optical portion will be (See page 20) ——— ——— 131. 8. —

From which must be deducted the cost of a reflector 14. —. —

which leaves the reduction for each 60° suppressed £ 117. 8. —

III. In Third Order Lights - composed of five segments - each of 72° - for every segment of 72° suppressed, the reduction in the price of the Optical portion will be (See page 30) 62. —. —

from which deducting the cost of the plated reflector 12. —. —

the net reduction of each segment of 72° suppressed will be £ 50. —. —

N.B. The cost of the mechanical parts of the Lights and of the Lanterns &c is in no degree whatever reduced by the suppression of one or more segments of the Optical portion, which affects the cost of that part of the apparatus only. —

3° The frame and accessories or "Armature" comprises the Cast Iron Column, the Table or Platform, & the uprights which support the Brass frame Work in which the Optical portion of the Apparatus is mounted.

4° The Lantern, (see page 4) which is glazed with Plate Glass 3/8 of an inch thick, is supplied with 2 spare panes of each ranged of Sizes for repairs, and comprises the Service Gallery or platform between the apparatus and the Lantern, the Cast Iron Steps leading up into the Light, the outside Balustrade, a lightning conductor & chain complete, & the blinds neccessary to prevent injury to the Lamp from the concentration of the rays of the Sun

5° The "Various Appurtenances" comprise a Stock of Sticks and Chimney glasses for 2 years' consumption, an assortment of all tools, cans, brushes, materials &c neccessary to keep the apparatus in good order, & also to make such repairs as the Keeper may be called upon to effect

6° The only Lamps used for the 1st, 2nd & 3rd Order Lights are mechanical Lamps, worked by clockwork, & having respectively 4, 3 & 2 concentric wicks for the 1st, 2nd & 3rd Order lights.

7° " Terms.— All the prices given in this book are net at our manufactory, but a Discount of 2½ p.c. is allowed for Cash payments within two months of the date of the Invoice.

PRICE OF A LIGHT OF THE FOURTH ORDER,

WITH SHORT ECLIPSES.

Optical Portion ...	One fixed apparatus, illuminating the whole of the horizon, (metal mountings included)	120 . 0 . 0
	Two revolving panels ... at ... £12.	24 . 0 . 0
Frame	One frame, and its accessaries	60 . 0 . 0
Lamps	Three lamps, and their accessaries	12 . 0 . 0
Rotatory Machine ...	One rotatory machine, and its accessaries	36 . 0 . 0
Lantern	One lantern, and its accessaries (see pages 4 & 29) ...	160 . 0 . 0
Various Appurtenances	Appurtenances and accessary expenses	16 . 0 . 0

Total. £428 . 0 . 0

Packing the apparatus in Double Boxes £6.
do of Lantern Fittings .... do — £3.
Carriage of the apparatus to London or Liverpool £3.
do of Lantern ..... do — £4.

See General Observations page 39.

FIXED LIGHTS OF THE FIFTH ORDER.

INTERNAL DIAMETER 14½ INCHES.

THE average range of these lights is 9 miles.

They are composed of a Lenticular cylinder, in the centre of which is the lamp.

Five Catadioptric prismatic rings, placed above the Lenticular cylinder.

Three Catadioptric prismatic rings, placed beneath the cylinder.

All these different parts are fixed on a brass frame.

PRICE OF A FIXED LIGHT OF THE FIFTH ORDER.

Illuminating the whole horizon or 360°.

	The price of an apparatus illuminating the whole horizon, or 360°, is		£72. 0. 0
	An apparatus illuminating 270°		
	An apparatus illuminating 180°		
Supporter of the Apparatus	A metal candelabrum and accessaries ...	£7. ...	£94. 0. 0
Lamps	Three lamps	£11. ...	
Lantern	One lantern, and its accessaries	£160 ...	
Various Appurtenances	Appurtenances, and accessary expenses ...	...	
	Wicks and glass chimnies	£16 ...	

Packing the apparatus in double Boxes £3. Total... £266. 0. 0

do. the Lantern & accessaries. or £3.

Carriage to London or Liverpool apparatus £2.

do .... do Lantern £4.

See General Observations page 39.

Prices of Fixed Lights of the Fifth Order,

Illuminating parts only of the Lenses, viz.

	270°	180°	90°
Apparatus ...	56.0.0	40	23
Plated Silver Reflector	3.12.0	7.4.0	10.16.0
	59.12.0	47.4.0	33.16.0
Candelabrum 7.0.0 Three Lamps 11.0.0 Lantern .. 160.0.0 Appurtenances 16.0.0	194.0.0	194.0.0	194.0.0
Total	£253.12.0	£241.4.0	£227.16.0

Packing and Carriage the same as for 360° Apparatus

See General Observations page 19

LIGHTS OF THE FIFTH ORDER,

WITH SHORT ECLIPSES.

INTERNAL DIAMETER 14½ INCHES.

THE average range of these lights is . . 9 . . miles.

They are, like those of the preceding orders, composed of two parts, the one Fixed, and the other Revolving. The fixed part contains the same pieces as the fixed light of the same order, and the revolving part is composed of two cylindrical panels, placed on a moveable frame, performing a revolution every minutes.

PRICE OF A LIGHT OF THE FIFTH ORDER,

WITH SHORT ECLIPSES.

Optical Portion ...	One fixed apparatus, illuminating three-fourths of the horizon	56. 0. 0
	Two moveable lenses ..@ £10.	20. 0. 0
Frame	One frame, and its accessaries	40. 0. 0
Lamps	Three lamps	11. 0. 0
Rotatory Machine...	One rotatory machine, and its accessaries	36. 0. 0
Lantern	One lantern, and its accessaries	160. 0. 0
Various Appurtenances.	Appurtenances, and accessary expenses...	16. 0. 0

Packing apparatus in Double Cases £5.
do Lantern & accessaries .. £3.
Carriage to London in Liverpool apparatus £3.
do ... do ..... Lantern £4.

Total £339. 0. 0

See General Observations page 39.

FIXED LIGHTS OF THE SIXTH ORDER.

INTERNAL DIAMETER $11\frac{3}{4}$ INCHES.

THE range of lights of the Sixth Order is . . 6. . miles.

They are composed of a Lenticular cylinder, in the centre of which is the lamp.

Catadioptric prismatic rings, placed above the Lenticular cylinder.

Catadioptric prismatic rings, placed beneath the cylinder.

All these different parts are fixed on a brass frame.

PRICE OF A FIXED LIGHT OF THE SIXTH ORDER.

Illuminating the whole horizon or 360°.

Optical Portion ...	Price of an apparatus illuminating ~~three fourths~~ the whole of the horizon		£40 . 0 . 0
	An apparatus illuminating 270°	see Contra	
	An apparatus illuminating 180°	see Contra	
Supporter of Apparatus	One metal candelabrum, and accessary parts ...	~~£7~~ £10	£193 . 0 . 0
Lamps	Three lamps		
Lantern	One lantern, with plate glass comprising the cupola	£16.4	
Various Appurtenances	Appurtenances, and accessary expenses	£16.	

Packing of the apparatus in double cases £3. 0

do. of the Lantern & accessaries .. do £3.

Carriage to London a Liverpool of the apparatus £2.

do .... do of the Lantern £4.

Total. ~~£~~233 . 0 . 0

See General observations page 39.

General Observations on Harbour Lights of the 4th, 5th & 6th Orders

When these Lights are not required to illuminate the whole horizon, one quarter, one half, or three quarters of the apparatus illuminating respectively 90°, 180° and 270° may be used, but these are the only divisions which can be made For these Lights either moderator or hydrostatic Lamps may be employed. The prices given are for the former discription, the others are somewhat lower.

Fifth & Sixth Order Lights are now rarely used but as fixed Lights, and the Sixth but seldom on account of their small dimensions, and feeble illuminating powers.

The observations 4, 5 & 7 page 32 are also applicable to these Lights.

Prices of Fixed Lights of the Sixth Order, - illuminating portions only of the horizon - viz:-

	270°	180°	90°
Apparatus ...	£31.0.0	22.0.0	13.0.0
Plated Silver Reflector	2.8.0	4.16.—	7.4.0
	33.8.0	26.16.0	20.4.—
Candelabrum — 7.0.0			
Three Lamps 10.0.0			
Lantern — 160.0.0	193.0.0	193.0.0	193.0.0
Appurtenances 16.0.0			
Total ..	£226.8.0	£219.16.0	£213.4.0

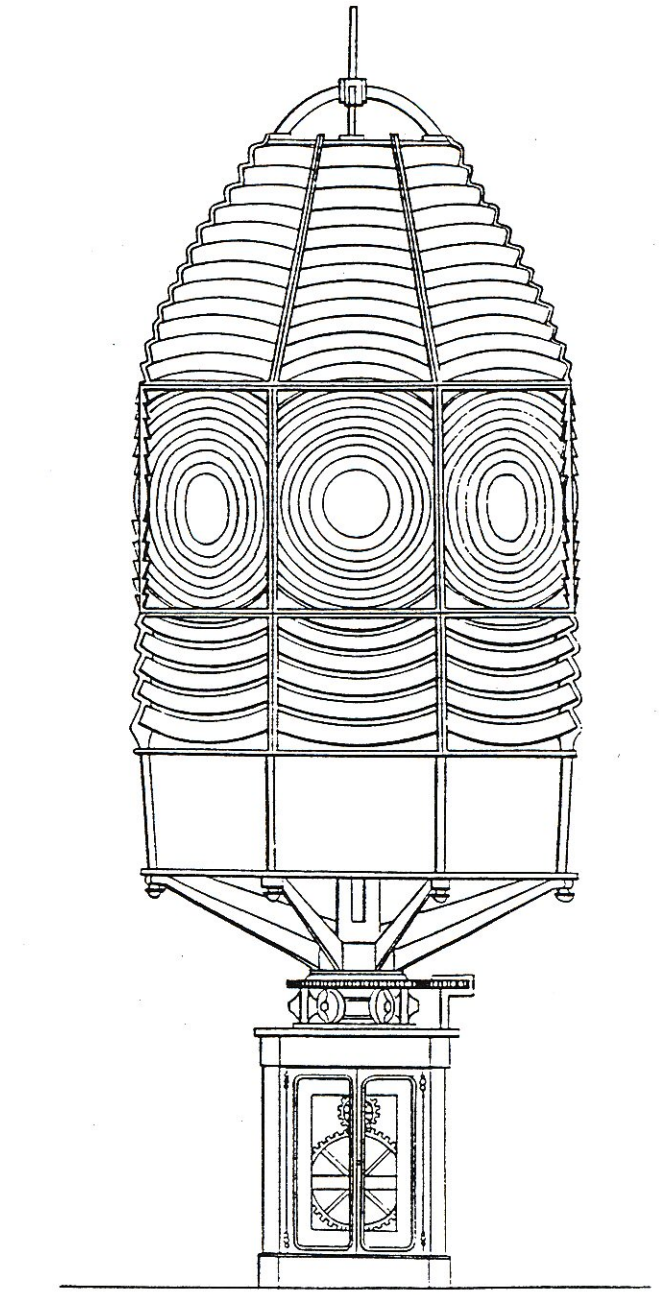
Packing & Carriage - the same as for 360° Apparatus.

See General Observations page 39.

These first Order Revolving Lights, on the Holophotal system, are also made to give eclipses at intervals of half a minute – the price of which apparatus we shall be prepared to furnish on application.

FIRST ORDER REVOLVING LIGHT.

(Holophotal System.)



LIGHTS OF THE SIXTH ORDER,

WITH SHORT ECLIPSES.

INTERNAL DIAMETER 11¾ INCHES.

THE average range of these lights is . .6. . . miles.

They are, like those of the preceding orders, composed of two parts, the one Fixed, and the other Revolving. The fixed part contains the same pieces as the fixed light of the same order, and the revolving part is composed of two cylindrical panels, placed on a moveable frame, performing a revolution every minutes.

PRICE OF A LIGHT OF THE SIXTH ORDER,

WITH SHORT ECLIPSES.

Optical Portion ...	One apparatus, illuminating three-fourths of the horizon...	31. 0. 0
	Two moveable lenses ... at £8	16. 0. 0
Frame	One frame, and its accessaries	32. 0. 0
Lantern	One lantern, with plate glass, and accessaries	160. 0. 0
Lamps	Three lamps	10. 0. 0
Rotatory Machine	One rotatory machine, and its accessaries	32. 0. 0
Various Appurtenances.	Appurtenances, and accessary expenses...	16. 0. 0

Packing in Double Cases of the Apparatus £5.
do. do. of the Lantern & accessaries £3.
Carriage to Liverpool & London of the Apparatus £3
do. do. of the Lantern ... £4.

Total... £297. 0. 0

The annual cost of these small apparatuses varies from to ... .

LANTERNS AND APPARATUSES FOR FLOATING LIGHTS.

In situations where it is requisite to have a Light to warn the mariner of danger, and there is no possibility of erecting a building, vessels "strongly constructed for the purpose" are usually moored; a light is exhibited at the Mast Head during the night and lowered into a house on deck at sunrise. The vessel is generally distinguished by a large ball in the day time.

This kind of lights admits only of two varieties, viz:—

Fixed and Flashing Lights.

Fixed Lights.—During many years these apparatuses consisted merely of lamps and parabolic reflectors. Some late improvements have permitted the introduction of A. FRESNEL's system. In this arrangement four Fifth Order lights are employed, reflectors being used at the back of each lamp for 148° of the circle.

They are arranged in such a manner that from any point of the horizon ~~three~~ two at least of these lights are constantly in sight.

Flashing Lights.—These lights are still constructed with reflectors only, and are manufactured by Mr. W. WILKINS, who, by introducing small parabolic reflectors and lamps gimbled and balanced to maintain their level when the vessel is rolling, has much improved the power of these lights.

T. UNDERWOOD, LITHOGRAPHER AND PRINTER, UNION PASSAGE, BIRMINGHAM.

HOLOPHOTAL SYSTEM.

Of late some important improvements have been introduced in Catadioptric Lights for Lighthouse illumination, by Mr. Thomas Stevenson, the eminent engineer to the Scotch Board of Lighthouses. These improvements, which have been classed under the name of "The Holophotal System," are applicable to all revolving lights and to the lights varied by short flashes.

APPLICATION OF THE HOLOPHOTAL SYSTEM TO FRESNEL'S REVOLVING LIGHTS.

Hitherto, in Catadioptric Revolving Lights, the central or refracting portion only was made to revolve and produce flashes and eclipses, and the upper and lower Catadioptric, or reflecting portions, have been constructed in the same way as for Fixed Lights. In some instances the upper Catadioptric portion was replaced by a compound arrangement of lenses and silvered mirrors revolving together with the central lenses, and like them producing alternate flashes and eclipses; but the loss of light produced by this compound arrangement of lenses and silvered mirrors was very considerable, the loss by absorption from metallic specula being generally believed to be no less than one half of the whole incident light. The advantage of employing, as extensively as possible, the principle of total reflection from glass, in place of ordinary reflection from metallic specula, induced Mr. Stevenson to make some researches as to the possibility of arranging the upper and lower Catadioptric portions of a light so as to produce eclipses and flashes simultaneously with the central portion. This was obtained by the following arrangement.

Retaining the central refracting lens of the light, Mr. Stevenson substituted for the usual Catadioptric portions a series of glass rings, which are the solids of revolution generated by the transverse section of the totally reflecting prisms used in fixed lights, round a horizontal axis passing through the flame, and coinciding with the axis of the annular refracting lenses. The distinguishing peculiarity of this arrangement is, that the prisms,—instead of transmitting the light in vertical planes, diverging all round as in Fresnel's Fixed Light apparatus—produce an extension of the lenticular action of the refracting annular lens, by collecting the light around its axis in the form of concentric hollow cylinders or portions of such cylinders.

PRICE OF A REVOLVING LIGHT OF THE FIRST ORDER.

With Eclipses at intervals of a minute.

(HOLOPHOTAL SYSTEM.)

Optical Portion	Eight annular panels, at £58	£464	
	Upper Catadioptric portion 8 panels	£72 .. 576	1456. 0. 0
	Lower Catadioptric portion 8 panels	£52 .. 416	
Lamps	Three four-wick lamps		84. 0. 0
Frame	One revolving frame, with accessaries		230. 0. 0
Rotatory Machine....	One rotatory machine		125. 0. 0
Lantern....	One lantern and its accessaries (See pages 4.t.32)		880. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses— One hundred and fifty glass chimnies, 150 feet of wicks of each of the 4 Nos., tin-work, brushes, shamoy leather, polishing powder, tools, &c.		48. 0. 0
	Total		£ 2826. 0. 0

Packing in double cases of the apparatus £32.
do .... do. of the Lantern & accessaries £28
Carriage to London or Liverpool of the Apparatus £10.
do ..... do. of the Lantern ... £20.

See General Observations page 45.

PRICE OF A REVOLVING LIGHT OF THE SECOND ORDER.

With Eclipses at intervals of a minute

(HOLOPHOTAL SYSTEM.)

Optical Portion	Six annular panels, at £48	£288.	
	Upper Catadioptric portion 6 panels at £62.	372.	876. 0. 0
	Lower Catadioptric portion 6 panels at £36	216.	
Lamps	Three three-wick lamps		75. 12. 0
Frame	One revolving frame, with accessaries		176. —. —
Rotatory Machine....	One rotatory machine		124. —. —
Lantern....	One lantern and its accessaries (see page 44-32)		600. 0. 0
Various Appurtenances.	Appurtenances and accessary expenses— One hundred and fifty glass chimnies, 150 feet of wicks of each of the 3 Nos., tin-work, brushes, shamoy leather, polishing powder, tools, &c.		36. 0. 0
	Total ...		£1887. 12. 0

Packing of the apparatus in double cases £22

" of the Lantern & accessaries ... " ..... £18.

Carriage to London & Liverpool of the apparatus. £9.

do ..... do. of the Lantern .. £16.

See Observations page 45.

APPLICATION OF THE HOLOPHOTAL SYSTEM TO FRESNEL'S FIXED LIGHT, VARIED BY SHORT ECLIPSES.

The Fixed Light, varied by short eclipses, invented by Fresnel—and improved as shown in the plate entitled "Patent Revolving Catadioptric Apparatus, with short eclipses and additional vertical lenses for increasing the light"—was produced by the revolution of straight prisms in front of a fixed light apparatus, so as to give occasional flashes of greater brilliancy.

In the Holophotal System the whole apparatus revolves. It consists of alternate portions of Fresnel's Fixed Light and of Fresnel's Revolving Light rendered Holophotal; one set of Holophotal Catadioptric prisms thus accomplishing the same result which was produced by fixed Catadioptric prisms, combined with vertical lenses in the other.

Observations on the 1st & 2nd Orders
Holophotal Lights

1st The Catadioptric portion of the 1st Order Lights, are formed of 17 prismatic rings for the upper part, and of 8 for the lower part.

2nd The Observations 3, 4, 5, 6 & 7 (page) 32 are also applicable to these Lights

PRICE OF A LIGHT OF THE FIRST ORDER,

WITH SHORT ECLIPSES.

(HOLOPHOTAL SYSTEM.)

Optical Portion	4 Cylindrical panels, at £56	224 . 0 . 0
	4 Annular panels, at £58	232 . 0 . 0
	4 Upper Catadioptric panels at £60	240 . 0 . 0
	4 Upper Catadioptric Holophotal panels, £72	288 . 0 . 0
	4 Lower Catadioptric panels .... at £45	180 . 0 . 0
	4 Lower Catadioptric Holophotal panels	208 . 0 . 0
Lamps	Three four-wick lamps.... .... £52	84 . 0 . 0
Frame	One revolving frame, with accessaries	230 . 0 . 0
Rotatory Machine....	One rotatory machine	128 . 0 . 0
Lantern....	One lantern and its accessaries (see p. 43.2)	380 . 0 . 0
Various Appurtenances.	Appurtenances and accessary expenses— One hundred and fifty glass chimnies, 150 feet of wicks of each of the 4 Nos., tin-work, brushes, shamoy leather, polishing powder, tools, &c.	48 . 0 . 0
	Total	£2742 . 0 . 0

Packing of the apparatus in double Cases £32.
do. of the Lantern & accessaries .... do. . £28

Carriage to Liverpool or London of the apparatus .. £40.
do .... do .. of the Lantern .. £20.

PRICE OF A LIGHT OF THE SECOND ORDER,

WITH SHORT ECLIPSES.

(HOLOPHOTAL SYSTEM.)

Optical Portion ...	3 Cylindrical panels at ... £48	144. 0. 0
	3 Annular panels .... at ... £48	144. 0. 0
	3 Upper Catadioptric panels at ... £52.	156. 0. 0
	3 Upper Catadioptric Holophotal panels at £62.	186. 0. 0
	3 Lower Catadioptric panels .... at £31. 8/—	94. 4—
	3 Lower Catadioptric Holophotal panels at £36.	108. 0. 0
Lamps	Three three-wick lamps	75. 12. —
Frame	One revolving frame, with accessaries	176. —. —
Rotatory Machine....	One rotatory machine	124. 0. 0
Lantern....	One lantern and its accessaries (see p. 4+32)	600. —. —
Various Appurtenances.	Appurtenances and accessary expenses— One hundred and fifty glass chimnies, 130 feet of wicks of each of the 3 Nos., tin-work, brushes, shamoy leather, polishing powder, tools, &c.	36. —. —
	Total	£1843. 16. 0

Packing of the apparatus in double Cases £22.
of the Lantern & accessaries ---- £18
Carriage to Leith or London of the apparatus £9.—
do ..... do ..... of the Lantern £16—

See Observations page 45.

APPLICATION OF THE HOLOPHOTAL SYSTEM TO FRESNEL'S HARBOUR FIXED LIGHT, VARIED BY SHORT ECLIPSES.

In these lights the whole system revolves, being composed of alternate portions of Fresnel's Fixed Harbour Lights and of Lights consisting of annular lenses and Catadioptric prisms, rendered Holophotal, as in the lights of a superior order with short eclipses, previously described.

PRICE OF A LIGHT OF THE FOURTH ORDER,

WITH SHORT ECLIPSES.

(HOLOPHOTAL SYSTEM.)

Optical Portion	One apparatus illuminating the whole horizon— Composed of 4 alternate cylindrical portions and of 2 annular holophotal portions (metal mountings included)	150 . 0 . 0
Frame....	One Frame and its accessaries	20 . 0 . 0
Lamps	Three lamps and their accessaries	12 . 0 . 0
Rotatory Machine	One rotatory machine and its accessaries	36 . 0 . 0
Lantern	One lantern and its accessaries	160 . 0 . 0
Various Appurtenances.	Appurtenances and accessary expenses	16 . 0 . 0
	Total ...	394 . 0 . 0

Packing of the apparatus in double Boxes £6.—
do. of the Lantern & accessaries ... £3.—
Carriage to London or Liverpool of the apparatus £3—
do ..... do ... of the Lantern £4—

PRICE OF A LIGHT OF THE FIFTH ORDER,

WITH SHORT ECLIPSES.

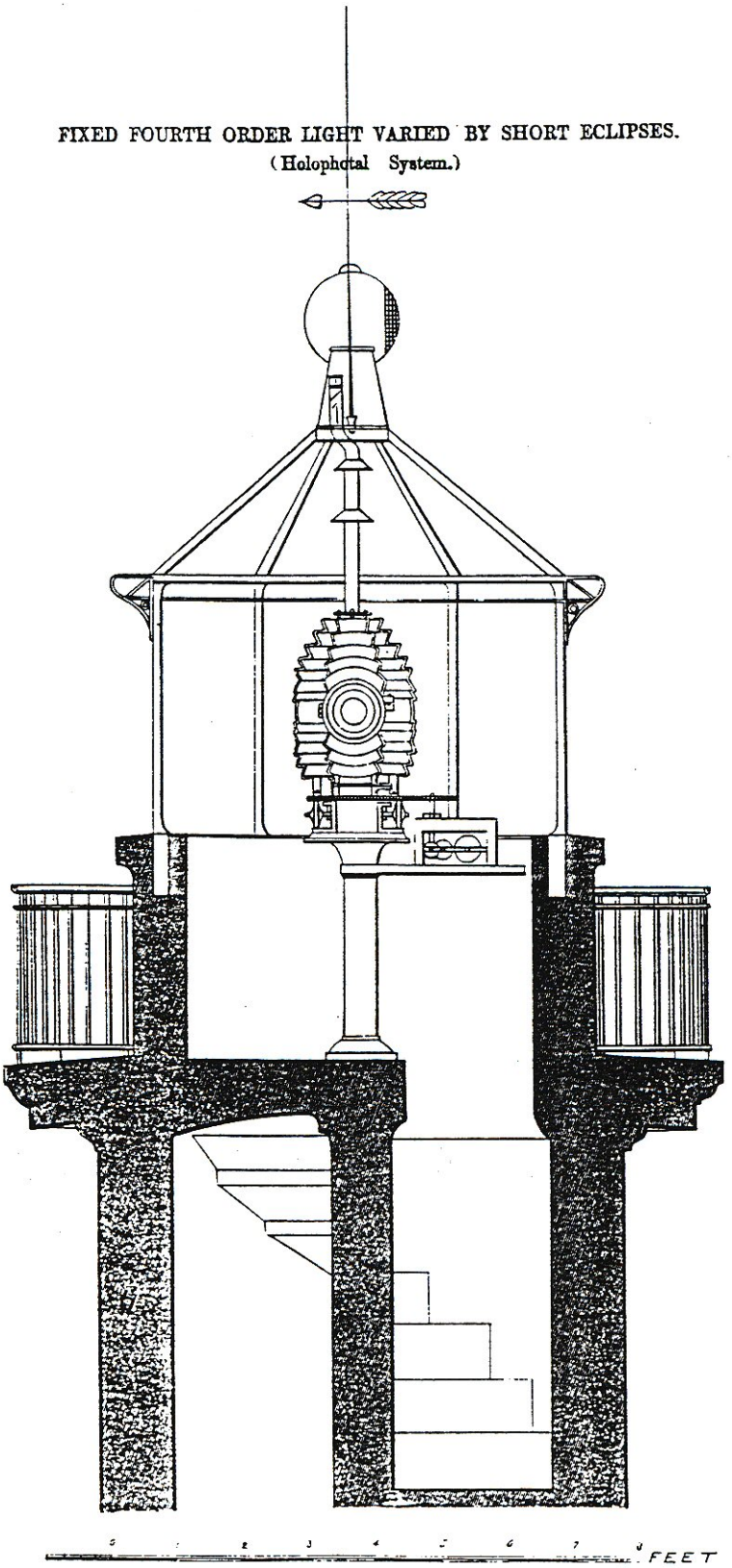
(HOLOPHOTAL SYSTEM.)

Optical Portion	One apparatus illuminating the whole horizon—composed of 4 alternate cylindrical portions and of 2 annular holophotal portions (metal mountings included)	100. 0. 0
Frame	One frame and its accessaries	15. 0. 0
Lamps	Three lamps and their accessaries	11. 0. 0
Rotatory Machine	One rotatory machine and its accessaries	36. 0. 0
Lantern	One lantern and its accessaries	160. 0. 0
Various Appurtenances	Appurtenances and accessary expenses	16. 0. 0
	Total	338. 0. 0

Packing of the Apparatus in double Boxes £5.
" of the Lantern and accessaries ... £3.
Carriage to Liverpool or London of the apparatus £2.-
do ..... do. of the Lantern .... £4.

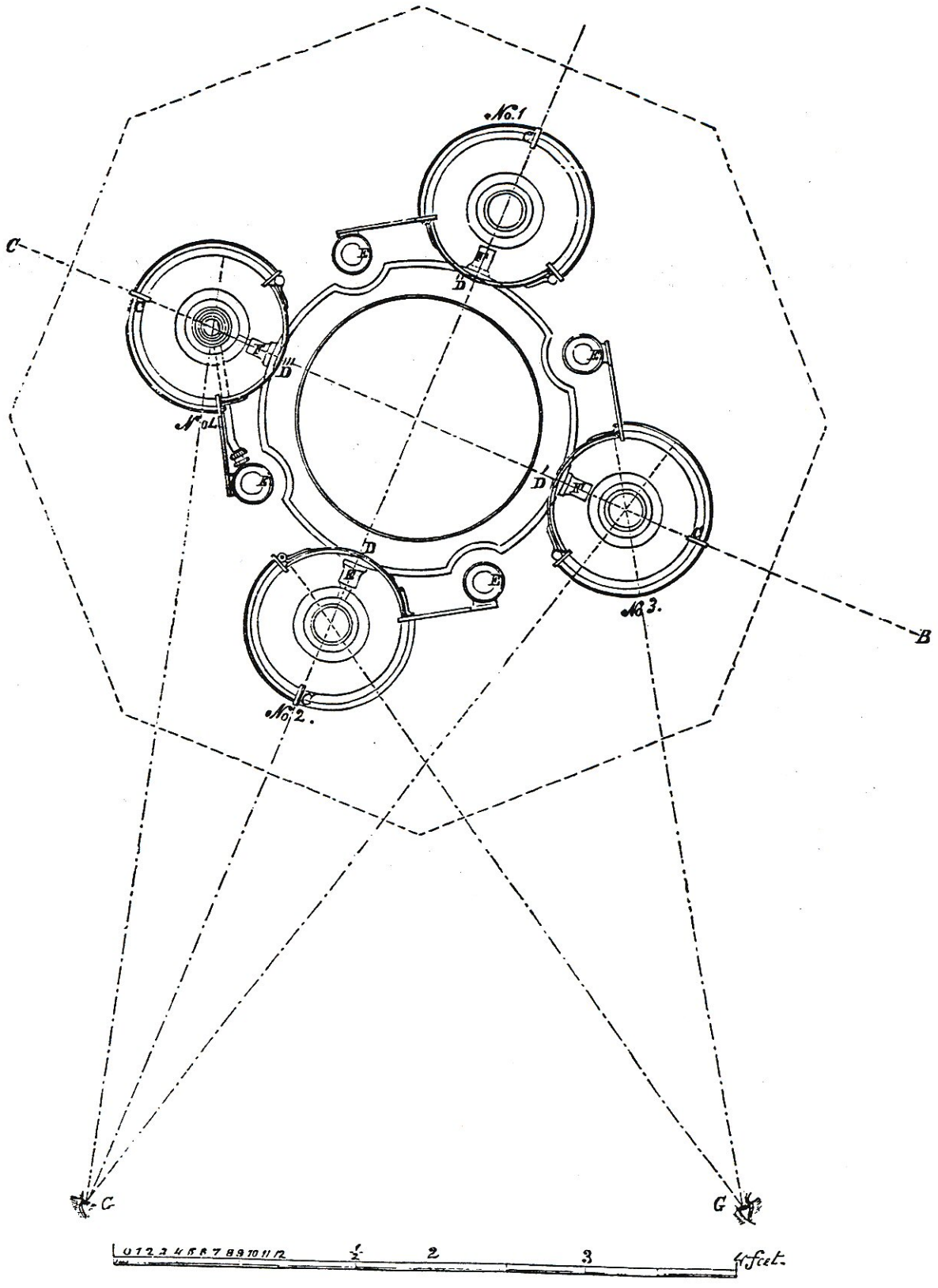
FIXED FOURTH ORDER LIGHT VARIED BY SHORT ECLIPSES.

(Holophotal System.)



IMPROVED ARRANGEMENT OF CATADIOPTRIC APPARATUS OF THE FIFTH ORDER, FOR LIGHT VESSELS.

PLAN.



APPLICATION OF THE HOLOPHOTAL SYSTEM TO REFLECTOR LIGHTS.

A large number of lights, whether fixed or revolving, are still composed of a set of lamps and parabolic reflectors placed round each lamp, as shown in Fig. 1.

It is quite obvious that this system is a very imperfect one: the diverging rays which are intercepted by the reflector are little more than what emanate from the back part of the flame, and nearly one half of the whole sphere of rays escape past the edge of the reflector and never reach the eye of the mariner.

To render the ordinary reflectors Holophotal, the small portion *a a* behind the parameter is cut off and is replaced by a spherical mirror and a lens L, with three Diacatoptric lenticular rings *p p* added in front.

Fig. 3 is another arrangement adopted to procure the same result.

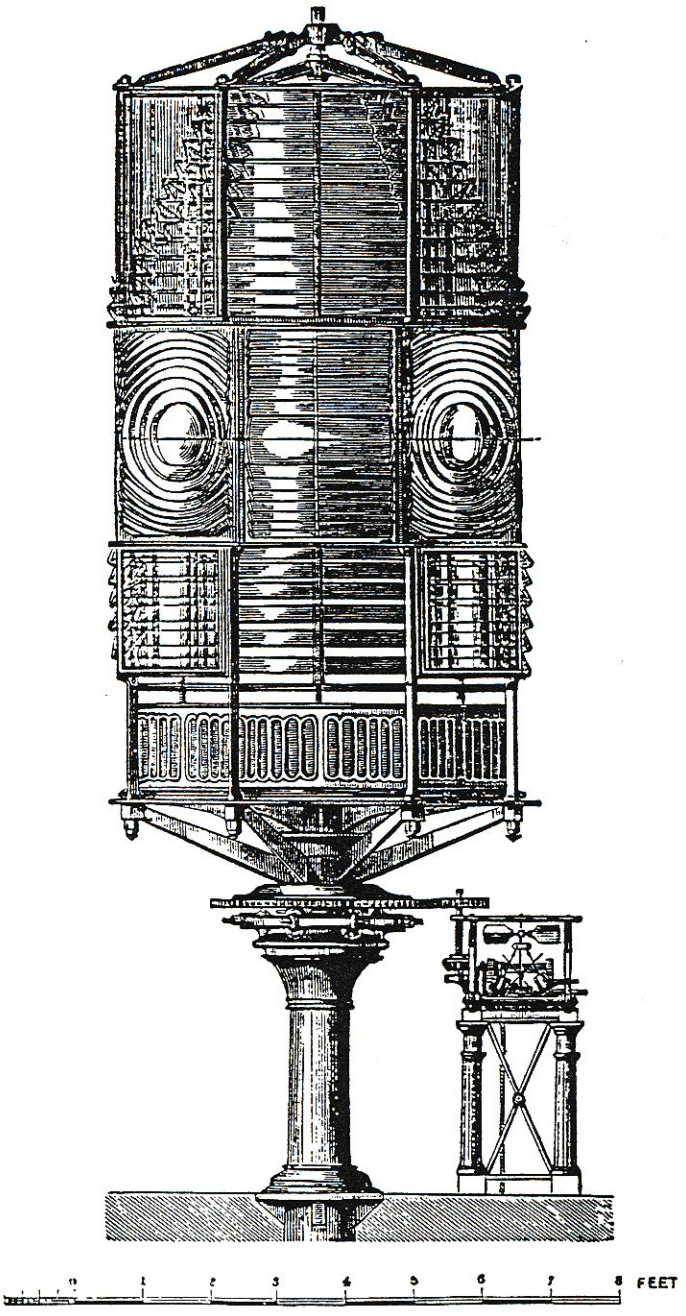
(Fig 2)

The price of a Lens 1 is £10.0.0.

PATENT REVOLVING CATADIOPTRIC APPARATUS,

OF THE FIRST ORDER,

With short Eclipses and additional Vertical Lenses for increasing the light, as shown in the Great Exhibition of 1851.



PATENT DIOPTRIC SIGNAL LANTERN.