SOLAR ECLIPSE EXPEDITION

TO

PORT DAVEY, TASMANIA

MAY 1910

REPORT

OF THE

SOLAR ECLIPSE EXPEDITION

TO PORT DAVEY, TASMANIA

MAY, 1910

BY

F. K. McCLEAN, F.R.A.S.,

AND OTHERS

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INTRODUCTION

Some apologies are, I think, necessary for this report on an Eclipse that was not observed. But my excuse is that there may be useful information contained in it, not only in the part that refers to the instruments, but also in the details of the general arrangements such as tents, food and drink, stores, etc., etc. Most persons who go out on an eclipse expedition have a thorough knowledge of their instruments and how to set them up, but a large number have only a very faint notion of the numberless preliminaries that are frequently almost as important as the instruments themselves. For this reason I have given a fairly detailed description of our stores in Chapter II.

Chapter IV. gives a description of the instruments, and Chapter V. contains a detailed report of the Determination of Position, as worked out, and will possibly supply useful hints to many, as it is written by Mr. J. Brooks, whose experience in Geodetic surveying has extended over half the Australian continent.

Chapter VI. is a short description by Mr. W. H. Wesley of the negatives obtained by the Rev. L. S. Macdougall and Mr. J. Booton at Queenstown, and which they very kindly allowed me to have.

The pictures and diagrams will help to show the reader the type of country and the life led in the wildest part of the island of Tasmania.

In conclusion I should like to express my best thanks to Mr. Howard Payn for his kindness in carefully reading through the proof sheets with me.

REPORT ON ECLIPSE EXPEDITION TO PORT DAVEY, TASMANIA

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CHAPTER I

PREPARATIONS FOR THE ECLIPSE

THE line of total eclipse of May 8th, 1910 (Local time, May 9th), touched no land except the Antarctic continent and Tasmania. The first was obviously impossible of access, and the latter place alone remained from which observations could be made. The conditions were of the worst, as the central line passed about 40 miles to the south of the island. The season was winter, the country very mountainous and the time of eclipse was within an hour of sunset, so that the sun's altitude was only 7° to 8° above the horizon. The weather in winter is bad, even on the east coast, while on the south and west the gales are continuous and the rainfall is measured by "yards" instead of inches.

For these reasons it was only natural that no official expedition should be sent from England nor from any other country except Australia, as the chances of success were very small and the cost and time required to reach Tasmania were very great. Many instruments were, however, lent by the Royal Society both to myself and to the Australian expedition under Mr. P. Baracchi, Government Astronomer of Victoria, with whom were working Mr. G. F. Dodwell, Government Astronomer of South Australia, Mr. C. J. Merfield, of Melbourne, Mr. A. W. Dobbie, of Adelaide, and others well known to science in Australasia.

Active preparations were commenced early in 1909, and it was found extremely difficult to obtain any information about the south coast of Tasmania. Through the kindness of General Tennant, R.E., F.R.S., I obtained some maps and letters regarding Port Davey, and also rainfall statistics. From these it was evident that it would be best to remain on the east coast, especially as at that time it was generally supposed that the Australian expedition would go to Port Davey. Besides Bruni Island there appeared to be possible sites at Port Esperance and Recherche Bay on the D'Entrecasteaux Channel, where breaks in the hills would leave open a portion of the western sky. Before I reached Hobart, however, further particulars reached me from Messrs. Brooks and Worthington which, coupled with the fact that Mr. Baracchi had settled to observe from Bruni Island, made me undetermined as to which locality I should choose until I had had time to visit them. From all reports it was evident that between Recherche Bay and Port Davey there was no site accessible either by land or water. A further possibility was to split up the expedition into two or even three camps, but on consideration it appeared best to keep together, as the number of observers was small enough even without sub-division.

The preparation of the instruments went on during the summer and autumn, and I must here express my very deep gratitude to Sir Norman Lockyer, K.C.B., to Dr. W. J. Lockyer, and to Mr. C. P. Butler, not only for the loan of two spectrographs and a plane mirror, but also for the continuous assistance with regard to the design and construction of the concave grating spectrographs, and for the calculations bearing on the eclipse. Also to the Government Grant Committee for the loan of a 16-inch coelostat which was overhauled by W. Ottway & Son, of Ealing, and sent by them direct to the docks. The 10 cases containing the 21-inch siderostat were sent to Cooke & Sons, of York, who had built it for me before the Flint Island eclipse, and they also forwarded it to the docks for shipment. All the instruments, except the long-focus Cooke lens, left London by the Shaw-Savill and Albion steamer *Ionic* in 29 cases on February 3rd, and arrived at Hobart on March 17th, where they were received and examined by Mr. Brooks, being insured for a total value of £1,050. The Customs duties were easily settled, owing to the kindness of the officials, and except for one small telescope of foreign make the only dutiable articles were the photographic plates.

Mr. A. Young and myself left England on January 15th, and travelled *via* America and Tahiti, where Mr. H. Winkelmann joined us. At Auckland I left them to follow later with Mr. S. G. Dowsett and Ernest Jeffs, who had been our steward at Flint Island, and was joining us again in Tasmania. Only spending a few days in Sydney I landed at Hobart on March 24th, where Mr. J. Brooks and Mr. J. Worthington had already been making full investigations of all possible localities, and I found that they both favoured Port Davey as the best site for the eclipse observations.

The northern limit of totality followed a line from Zeehan on the west to Maria Island on the east coast, but, owing to the shortness of totality so far north of the central line, only sites were considered that lay to the south of the latitude of Hobart. It could hardly be foreseen that the only view of the eclipse would be from Queenstown, near Macquarie harbour, which lies well to the north of this line. The whole of this area is mountainous in the extreme, and is mostly impenetrable bush, with no roads whatever except the one from Hobart to Franklin, Dover and Southport, along the east coast and one that runs inland to the Hartz Mountains. Before my arrival Mr. Worthington had traversed the roads to Southport and reported that there were no good sites, and later we motored over a great part of it again and found that everywhere the country consisted of lofty hills and mountains which entirely obscured the western horizon except at Port Esperance, where a valley breaks through leaving a very small opening of sky and an horizon of about 2° altitude which would enable observations to be made from Hope Island situated in the mouth of the harbour. But the presence of Adamson Peak, 4,000 feet high, nearly in the line of eclipse, made it extremely likely that clouds would form and lie there when the rest of the sky was clear, and the site was rejected unless no better could be found. We had no time to visit the

Hartz Mountains, but as they were in the centre of very rough country it is not likely that they would have offered any possible camp, and Mount Picton and the Arthur range were to the west of them. Neither did we examine Bruni Island, for Mr. Baracchi had already chosen his site there at Mills Reef.

In the choice of places for observing the eclipse the following table indicates the time and position for several possible stations:—

	Latitude.	Longitude.	Eclipse.		Time of		Length of Totality.	Time of Sunset.
			Bearing.	Altitude.	2nd Contact.	3rd Contact.		
	° ′ ″	° ′ ″	° ′	° ′	h. m. s.	h. m. s.	m. s.	h. m. s.
Pt. Davey	43 20 0	146 0 0	301 0	8 0	3 55 55	3 59 25	3 30	4 52 0
S. Cape	43 39 15	146 51 30	303 15	—	3 59 35	4 3 7	3 32	4 51 30
Dover	43 19 30	147 2 0	303 0	—	4 1 5	4 4 27	3 22	4 52 30
Hobart	42 53 22	147 20 28	302 0	7 3	4 3 30	4 6 24	2 54	4 53 0
Mills Reef (Bruni) ...	43 20 0	147 15 0	301 42	7 12	4 2 5	4 5 25	3 20	4 52 30

It was then necessary to find out by what means we could reach the west coast, and we called on Mr. C. H. Hughes, the Manager of the Union Steamship Co., at Hobart. Their steamer the *Wainui*, of 650 tons, travels between Hobart, Strahan and Melbourne, passing Port Davey, and he very kindly made arrangements for it to call in there at any time we wished, both on a preliminary trip and also during our stay there, if we settled on that site.

At the time we were making these inquiries the steamer was at Melbourne, so we had to join it at Strahan on its return journey. To do this it was necessary to spend the better part of two days in the train, travelling *via* Launceston to Burnie, where we stayed the night, reaching Strahan on Macquarie harbour the following afternoon. Here we were met by Mr. E. A. Eva, Local Manager of the S.S. Company, who on the arrival of the *Wainui*, introduced us to Captain K. Livingstone, whose unrivalled knowledge of the coast was of great assistance to us. Leaving Strahan in the evening we were in Port Davey before daylight and examined the shores of Bathurst Channel for a possible position. Port Davey itself faces south-west, and with its wide entrance is open to the huge rollers that help to make this coast one of the most dangerous in the world. But a couple of miles inside on the east are the Breaksea Islands, behind which a long, deep-water harbour opens, known as Bathurst Channel, where ships frequently take refuge in bad weather. It is entirely protected from heavy seas, and the coves, with which it abounds, are good shelter from the wind. We commenced with the south shore, but the hills were too steep and high for a small number of us to be able to carry the instruments up. So we crossed to the north side and here found a small promontory called Hixson Point, only 100 feet high and facing direct towards the eclipse. From the top of this point the bearing of Turnbull Head on the south of the channel was 8° north of west, and that of Milner Head on the north shore was 40° north of west. Between was the very low horizon of the land on the west side of

Port Davey, giving a clear view in the direction of the eclipse. From the point of view of position it was ideal, and for accessibility and the transport of the instruments it was comparatively easy. But against it were the notorious hurricanes that sweep that coast, and the enormous rainfall. We visited it on a fine day almost without wind, and throughout the morning with a bright sky, though rain fell as we left in the afternoon. On the east coast the winds were certain to be less violent, but even there the rainfall during the winter is large. Mr. Brooks, Mr. Worthington and myself decided unanimously on Port Davey as the site for the expedition, and in spite of the conditions we experienced later I do not think we were wrong. The fact that on the west coast only (though much further north) was the total phase seen, shows that it is useless to ignore those places which are condemned on their weather statistics.

After leaving Port Davey we steamed along the south coast reaching the entrance to the D'Entrecasteaux Channel as night fell. A more forbidding coast it would be impossible to imagine. The cliffs rose sheer from the sea, except for an occasional stretch of sand where the breakers would have prevented any landing. Close in to the cliffs and far out to sea stand pinnacles of rock. The "Great Witch" rises nearly 1,200 feet without a foothold. Maatsuyker Island, on which a lighthouse stands, is over 900 feet high, but less precipitous and of greater extent. It had been mentioned as a possible place for observation, but it would have had to have been the only place before we would have chosen it. As we came to the South Cape the huge mass of La Perouse, 4,000 feet high, showed what view would be obtained from Recherche Bay. We steamed up the channel after dark, arriving in Hobart just before midnight, so that we did not obtain a view of the Bruni Island site at Mills Reef.

Having fixed upon our site at Hixson Point, Port Davey, we spent the next nine days in purchasing all the stores, tents, food and drink and other necessaries that were required, and of which a fairly complete list is given in the next chapter. Mr. Hughes, of the Union Steamship Co., arranged for the *Wainui*, which was leaving on Saturday, April 9th, to call in at Port Davey the following day and land us.

On the 7th and 8th the remainder of our party arrived in Hobart, and the expedition, which started on the evening of the 9th, was made up of the following eight persons:

F. K. McClean, F.R.A.S., England.
Joseph Brooks, F.R.A.S., F.R.G.S., Retired Surveyor in Charge, Trig. Survey, N.S.W.
J. Worthington, F.R.A.S., England.
A. Young, A.R.S.M., England.
H. Winkelmann, Auckland.
S. G. Dowsett, Auckland.
Ernest Jeffs, steward, Auckland.
Arthur Wilson, carpenter and assistant-steward, Hobart.

At a later date the party was increased to nine by the arrival of J. Short, F.R.A.S., of the Sydney Observatory, N.S.W.

CHAPTER II

TRANSPORT, STORES, Etc.

After we returned from the preliminary trip to Port Davey our time was fully occupied in arranging for and purchasing tents, camp equipment, food and drink, and all the other necessaries for a month's stay in an uninhabited and desolate locality. We were warned that there was absolutely nothing to live on in the neighbourhood except the fish we could catch, and a few wallaby, wombats, and kangaroos, and we decided to ignore these in provisioning the camp. It was well that we did, as for long periods it was too rough to take a boat out for fishing, and sharks were very common and bit through the lines and damaged badly our "Graball" net. We never had time to go out with a gun during the whole of our stay, though we had two with us, one kindly lent by Mr. Reade, of the *Wainui*, and the other by Mrs. Johnson, of Eltham, Hobart, at whose house we stayed, and whose kindness and assistance went far to make the period of preparation one of enjoyment and comfort.

We also arranged our commissariat on such a scale that we should be able to last out without any intermediate call from the *Wainui*, as the programme which Mr. Hughes made for the ship was that all calls should be entirely at the discretion of the captain. This programme was as follows:—

Leave Hobart	April 9th,
Arrive Port Davey	,, 10th,

and assist instruments and stores on shore.

Call	Port	Davey	about	April	18th,	*en*	*route*	for Hobart;
,,	,,	,,		,,	20th,	,,	,,	Melbourne;
,,	,,	,,		,,	28th,	,,	,,	Hobart;
,,	,,	,,		May	1st,	,,	,,	Melbourne;
,,	,,	,,		,,	9th,	,,	,,	Hobart;
Arrive	,,	,,		,,	11th,	,,	,,	Melbourne,

and pick up Expedition and take them to Melbourne direct. This programme was carried out with small variations, due to the weather conditions, and we obtained bread at each call and did not in consequence use much of the flour we had taken with us. We were also enabled to send for many other articles, which were found to be necessary or desirable, and we received letters and newspapers which kept us in touch with the world.

The Union S.S. Co. also supplied us with a whaleboat during our time at Port Davey, and we hoped to be able to make expeditions across the harbour; but the wild weather prevented that, even if we had had sufficient time, and it was only used for fishing and for meeting the *Wainui* when she came in.

Sleeping accommodation was required for nine persons—Mr. Brooks already had a tent and also Mr. Worthington. On inquiry we found that it was nearly as cheap to buy second-hand tents as to hire them for such a trip as we were undertaking, and under such weather conditions. Also in view of the eclipse at Vavau, in April, 1911, they would be of use to us again. I therefore bought six double fly tents, of which five were old (but good) and one new. The following is a list giving their dimensions:—

1	tent	12 ft. × 18 ft.	(for housing the instruments).
1	,,	12 ft. × 12 ft.	(dining tent).
1	,,	6 ft. × 9 ft.	(dark room).
2	,,	9 ft. × 12 ft.	(sleeping).
1	,,	8 ft. × 10 ft.	(,, new).
		Also—	
1	,,	10 ft. × 10 ft.	(Mr. Brooks).
1	,,	8 ft. × 10 ft.	(Mr. Worthington).

The instrument tent was found to be none too large, but this was due to the weather which forced us to keep everything under cover the greater part of the time, but in ordinary circumstances it would have been ample. The dark tent also was hardly of sufficient size for convenience, especially in the handling of the dark slide of the concave grating spectrograph (Plate 27). It was lined with Japara, dyed dark red, and could only be used at night, as too much light found its way in. A green lining in addition is being made for Vavau.

For a cook-house we took 8 sheets of 8 ft. corrugated iron, sufficient for the roof and back and part of one side. The uprights were 3 × 2 timber and the roof pieces 2 × 2. The sides were filled with brushwood and the front left open (Plate 9).

Three table tops were taken, each 6 ft. × 3 ft., tongued and grooved, for the dining tent, the cook-house and the dark room. The last two were, however, divided up, being too large, and the extra pieces used for book-shelves and such like.

Besides these we took the following timber, viz.:—

18	pieces	3 in. × 2 in.	and	4 ft.	long,
12	,,	3 in. × 2 in.	,,	9 ,,	,,
12	,,	2 in. × 2 in.	,,	9 ,,	,,
12	,,	3 in. × 1 in.	,,	8 ,,	,,

which were used for table legs, cook-house frame, instrument supports, pulley gallows, and also for carrying the cases up the hill. This quantity of cut wood proved to be sufficient, as we had an ample supply of saplings in the bush round the camp for rough work.

For chairs we used the boxes containing stores except that we took 4 canvas deck chairs which were, however, used nearly as much for placing instruments on as for sitting purposes.

Our 8 bunks were constructed very strong and large and could be rolled up for transport. As mattresses we took out what are commonly known as "donkeys' breakfasts," being simply rough canvas bags containing straw. Rough bolsters and a couple of blankets and 2 towels and soap completed each person's kit except for what he might have brought with him.

Fifteen yards of linoleum, 4 ft. wide, were taken, and each tent was supplied with a strip, which added greatly to the comfort and cleanliness of the camp. It was also used for covering the tables, and what remained came in useful in mixing the concrete for the instrument foundations.

For protecting the food from flies, 12 yds. of mosquito netting, $1\frac{3}{4}$ yds. wide, were taken, and proved very useful, though the quantity was excessive.

A large number of empty kerosene tins were taken, as they are always extremely useful for many purposes. One was used for a water tank for the dark tent, being hauled up a neighbouring tree to give a good pressure, and connected to the tent by 12 yds. of rubber tube fitted with a vulcanite tap. Also for washing photo plates and for cookery purposes and boiling water they were invaluable.

The other stores taken were as follows:—

4 bags cement; for instrument foundation.

39 yards oiled Japara; for instrument coverings.

48 yards black Italian cloth; for camera tubes.

6 hurricane lamps.

1 bullseye lamp; for time keeper at eclipse and for theodolite reading at night.

4 ruby lamps; for dark room and for use during eclipse.

100 lbs. Manila rope ($\frac{1}{2}$ in.)—this amount would not be required in ordinary circumstances.

2 hanks white cotton line ($\frac{1}{4}$ in.); for slow motions and other purposes.

1 hank twine, and needles.

50 ft. × 6 ft. canvas; for wind screens.

4 double iron blocks ($1\frac{1}{2}$ in.); for slow motions.

4 single iron blocks ($1\frac{1}{2}$ in.).

6 single wooden blocks (2 in.) for clock weights.

Block and tackle, 1 double pulley, 1 single pulley, 100 ft. rope ($\frac{3}{4}$ in.), 2 10 ft. slings, 2 pairs clip hooks, 2 planks 9 in. × 16 ft.; for hauling the cases up on to the shore.

3 axes, 2 hoes, 1 bushhook, 1 spade, 1 maul, nails, tacks, wire, sharpening stone; in addition to tools taken out from England.

Dead black paint, white enamel paint, and brushes.
1 bath which was used for washing dishes, clothes, sand, etc.
Dish cloths, broom, blacklead, tin opener, and corkscrew.
Rangoon oil, machine oil, Neatsfoot oil, and oil-can and funnel.
Liquid glue and seccotine.
2 tins kerosene ($8\frac{1}{4}$ gals.), and pump.
1 lb. vaseline.
6 sheets white cardboard.
Bull dog clips, drawing pins, and ink.
1 alarm clock.
1 water bag.
1 hammock.
Fish lines, hooks, and sinkers.
Graball net, and crayfish net, and cartridges.
Matches, candles, knife polish, washing soda, soap.

In addition to these a large tarpaulin was found absolutely necessary. Mr. Brooks brought one and later we borrowed a second from the ship, from whom we also borrowed a second block and tackle.

Out of the above list several articles were sent for after we were at Port Davey. We started with only 4 hurricane lamps, but found this insufficient, and it would really have been best for everyone to have had one to himself. The bull's-eye lamp was also sent for, and some oil and extra rope were also found to be necessary owing to the amount of strengthening work required to combat the wind, and also canvas for the wind screens. An additional length of black Italian cloth was also purchased, but was not used.

Whereas in the above everything was bought on a lavish scale, in buying hardware for the camp we kept as near as possible to the minimum amount, as the following list will show:—

2 billy cans.
8 enamel cups and saucers.
12 large enamel plates.
12 small ,, ,,
8 knives and forks.
8 tea spoons.
8 dessert spoons.
1 baking dish.
1 camp oven.
1 round bake tin.
2 basting spoons.
2 fire pots.
1 large enamel dish.
1 enamel teapot.
1 ,, jug.
2 pie dishes.

As has been mentioned previously, we arranged our food supply on the possibility of having to remain the whole month without a call from the ship, but if that had occurred we should have run entirely out of vegetables and should have had to do without soup or eggs for the latter part of the time. The large quantity of flour remaining was due to our obtaining bread from the ship when it came in. If the weather had been warmer there would certainly not have been so much beer and lime juice remaining, and in a tropical climate the supply would have been insufficient even with four members of the party who were either teetotallers or practically so.

In addition to this we had an excellent supply of water from a stream running through the camp, although it was decidedly peaty, which it would not have been safe to drink in a tropical country or where there was a chance of pollution.

The other items of which there was a considerable excess were dates, jam, butter and milk.

The following is a list of the food and drink:—

1½	doz. lime juice. 13 bottles unused.	2	doz. cabbages.
1½	doz. whisky. 4 bottles unused.	2	cases tomatoes.
2	bottles brandy (medicinal). 1 bottle unused.	42	lbs. onions.
		1	doz. lbs. carrots.
12	dozen ale. 4 doz. unused.	1	doz. lbs. pumpkins.
3	tins China tea. 2 lbs. unused.	2	cases apples.
1	doz. tins coffee.	14	lbs. dried apricots.
1	doz. tins cocoa.	14	lbs. dried peaches.
1	case condensed milk. 14 tins unused.	3	doz. packets dates. 14 packets unused.
4	cwt. flour (8 bags). 4 bags unused.	7	lbs. currants.
39	loaves.	7	lbs. raisins.
2	bags oatmeal.	1	case jams. 14 tins unused.
2	tins biscuits.	4	tins golden syrup. 1 tin unused.
1	doz. packets baking powder. ? unused.	1	cheese.
12	lbs. cornflour. 5 packets unused.	1	box butter. 14 lbs. unused.
14	lbs. rice.	1	bag sugar.
10	doz. eggs.	2	bags salt.
5	doz. tins soup.	1	tin pepper.
1	cask of 150 lbs. salt beef.	2	tins mustard.
1	side bacon.	1	bottle cayenne.
2½	doz. tins beef.	3	tins curry powder. 1 tin unused.
2½	doz. tins mutton.	2	bottles vinegar.
1	doz. tins sheep tongue.	3	bottles anchovy sauce. 1 bottle unused.
4	tins ox tongue.	3	bottles Worcester sauce.
1	doz. tins sardines.	3	bottles chutney.
2	bags potatoes.	6	bottles pickles. 2 bottles unused.

What remained of these food stuffs was divided between the two miners who assisted us both on landing and on leaving, and the Cottage Hospital at Strahan.

In addition to the stores already mentioned there were medicines and bandages, of which very little was happily required, and photographic material of which a large proportion was unhappily not required, owing to the impossibility of obtaining even experimental photographs with the instruments. The supply of plates was sufficient not only for the final results we hoped for and the trial photographs, but also for all views taken of the camp and observatory. Thanks to the energy and skill of Mr. Winkelmann we have a large number of these which he obtained in spite of cloudy skies and even rain, and which show the various stages of the instruments and the camp and the surrounding country.

A few figures as regards the cost of the expedition may be of use for those who intend to observe eclipses—but in these figures no mention is made of steamer tickets or of any of the personal expenses of members of the party in getting to the starting point, or of salaries or retaining fees; these figures increase the cost manifold if the eclipse is in an out of the way part of the world, but can be obtained to a great extent from railway and steamship guides. Only the total cost of transport of the instruments is taken into full consideration.

In this case Hobart is taken as the starting point and Melbourne the finishing point of the expedition—except, as has been said, for the instruments.

	£
Freight of instruments	56
Transport, ship delay and other expenses	166
Tents	22
Tools, rope, timber, hardware, etc.	46
Food and drink	51
Photo material and medicine	6
	£347

Lastly it must be borne in mind that an enormous amount depends on the people with whom one has to deal. It has been my good luck both on this occasion, and on the Flint Island expedition, to have received from the Union Steamship Co. such consideration and assistance that all difficulties have disappeared.

Also I must thank Mr. J. G. Turner, of Hobart, who provisioned us, and who also went out of his way to assist us not only while we were in Hobart, but also obtained and sent to us anything we required while we were at Port Davey.

Also our thanks are due to the firm of Macmillan, Dale, and Macmillan, of Hobart, who in spite of the shortness of time completed our camp outfit to the absolute satisfaction of us all.

CHAPTER III

THE EXPEDITION AT PORT DAVEY

AT 9 P.M. on April 9th we left Hobart in the *Wainui* with 120 cases and packages, exclusive of private kit, and at daybreak were passing Maatsuyker Island. Rain was falling in showers as we turned the South West Cape, and it did not clear till we entered Port Davey at half-past eight. From then on the sun shone till late in the afternoon and the weather conditions were all that could be desired. The landing took place at two spots, one for the instruments and one for the camp. A short description of Hixson Point and its surroundings will help to explain the incidents in the diary. Coming in from the open harbour of Port Davey the Breaksea Islands are passed and the entrance to Bathurst Channel opens up between Milner Head and Turnbull Head. About a mile further on the channel divides into two: on the left is Bramble Cove, overshadowed by the bare rocks of Mount Misery, and on the right Bathurst Channel continues till it is broken by Munday Island, only to continue beyond, past Schooner Cove, which is the refuge harbour, for many winding miles into the heart of the mountains (Plates 1, 2, and 3).

Between these two stretches of water lies Hixson Point, with Sarah Island at its extreme end. Only about a quarter of a mile wide and 100 ft. above the sea, at its highest point, and covered by rough scrub two feet high, interlaced with button grass, it points direct through the opening of the channel towards the west-north-west. The shores in many places rise only some 6 to 8 feet perpendicularly, above which is the fairly level scrub ground, and at the foot a narrow strip of broken rocks gives a foothold for landing. On the Bathurst Channel side deep water is found close in shore, saving the labour of a long pull. At the summit is a level area about 70 feet across with a small patch of 10 ft. high bush on the south-east side where the ground slopes away. In places rock crops up, but there is usually about 12 to 14 inches of peat above it covered with a tough layer of grass roots. From this level patch a hogback ridge follows the shore of Bramble Cove until it joins the spurs of Mount Misery. About half a mile up Bathurst Channel from the end of the point is a small cove, at the head of which a stream breaks its way through some thick bush from the hills above. Sheltered from the wind on three sides it offers an ideal spot for a camp, although the water is shallow and landing has to be effected on the rocks 150 feet from the head of the bay. This was the spot we chose for our camp and while one boat was taking the instruments to the rocky edge of Hixson Point another brought the tents and stores to the cover.

The instruments were hauled up the six foot bluff by rope and tackle on two 16 feet planks (Plates 4 and 5). At the foot a skid rested on the thwart of the boat and on two exposed rocks. Thirty-two cases of instruments, besides the instrument tent, cement, and timber were landed here without mishap, and left covered by the tarpaulin, until such time as they could be carried up the hill. Meanwhile at the camp site all the other tents and the stores and luggage were landed, though unfortunately some of them were considerably wetted. The landing commenced at 9 o'clock and everything was on shore by two in the afternoon thanks greatly to the energy of Mr. Richardson, Chief Officer of the *Wainui*. We also received considerable assistance from two tin miners, named Mick Phelan and Alec Huchings, who were hunting on the south side of the channel, who also helped us greatly during the next two days in clearing the path to the observatory.

After the ship had left and the tarpaulin over the instrument cases was well pegged down we turned our attention entirely to the camp. Much cutting had to be done as the bush came down to the edge of the shore. Most of the tents were placed well among the trees giving them complete protection from the weather. As a consequence the only troubles we had later were with the dining tent (Plate 6), which was partly exposed and which required additional ropes stretched across it and pegged down; and also with my tent, when on a night rather worse than the rest, a stream broke out in it and there was an inch of water over the linoleum next morning. Also the fire trench in the cook-house was frequently flooded out in spite of extensive trenching, and in the intervals of cooking the dinner Jeffs had to bale the water out of the fireplace.

Our programme for each day was as follows :—

At about 6 to 6.30 we were called and found tea, coffee, or cocoa awaiting us in the cook-house. After that, unless under exceptional circumstances, there was nothing to do till 8 o'clock breakfast, except wash, dress, and tidy up the tents. The stream through the camp with its deep pools and the cove alongside offered a choice of fresh or salt water bathing, which, although most decidedly cold, was taken advantage of with a freedom which would have been impossible had ladies been present. Our drinking water was taken from above a small waterfall where pollution was practically impossible. After breakfast the chronometer and official watches were wound and their rates taken, and the general work of the day proceeded till dark, except for the luncheon interval at 1 o'clock. Dinner took place at 6.30, after which those who had no work to do amused themselves with music and cards till bedtime. We had with us an accordion and a concertina and several pocket instruments, later on a pair of bones were obtained from a sirloin of beef, which had accidentally come to us instead of going to a Dr. Brooks living near Hobart.

From the camp to the observatory was about 600 yards, and a path had to be cut partly through thick bush to the top of the hogback ridge and then through the ground scrub, which stood some 2 ft. high (Plate 7). Also another track was necessary from the landing-place of the instruments to the observatory, a distance of about a furlong. The instrument tent was first erected in the open on the east side of the summit (Plate 8), but when our first gale started on April 14th we struck it quickly and cut a space for it in the patch of low bush alongside. Even here it had to be strengthened by additional guys and holding down ropes over the fly, and before we left it had been torn to ribbands where the drummets were supposed to hold it down, and large rents showed on the ridge and ends.

As soon as we had the paths nearly completed and the instrument tent up, the work of carrying the cases was taken in hand (Plate 10). Though the distance was short and the hill only 100 ft. high, it was not until April 20th, 10 days after landing, that the last case reached the observatory. The continual rain made the ground so greasy that it was with difficulty that we kept our footing, and the frequency of the showers delayed us, as we were at that time still hoping to keep the instruments dry. A few of the cases required only one person, but for the majority four were needed, using two 9 ft. timbers below which the case was slung. With some we removed the lids and the detached parts of the instruments in order to lighten the load. It was in fact a case of body being of infinitely greater value than brain.

Nor was this all the heavy work. The nearest sand was at the camp 600 yards away, which, after being well washed in the stream (Plate 11), had to be carried in bags up the greasy paths, as well as the water, as that on the surface of the ground was so full of dirt and soil that it was useless for mixing the cement. The stone for the concrete we had to quarry off the exposed rocks, and also a fair quantity to weight the case on which the coelostat stood. If we had had to obtain more for clock weights the labour would have been very great, but we carried weights with us, contrary to what is, I believe, the usual custom. By the 20th all this was finished and the foundations for the siderostat and coelostat were laid (Plate 12). We made no other solid foundations but used the packing cases for some of the instruments, and for others built trestles which were easily adjusted as to height with a few taps from a mallet.

In the meantime, in addition to the gales and the excitement of continually saving the instrument tent from collapse, we had narrowly escaped a much greater danger. On Sunday, the 17th, we had been unpacking some cases and had left a large case packed tight with straw in the open, some 50 feet from the tent. There was nothing apparently wrong when we went down to lunch, but three-quarters of an hour later smoke was pouring across the camp, and we rushed up the hill to find a line of fire from side to side of the promontory and the instrument tent hidden by the clouds of smoke (Plate 13). As we approached the flag-pole fell, but by continuous beating we kept the fire from the tent. The original site of the tent was burnt out, but the wet bush, where it had finally been set up, had held the flames in check, although within 4 feet of one corner they were licking round the saplings to which the guys were fixed. Having checked the fire at this point the greater number of the party went to fight the fire in its advance on the camp, while two remained to keep it away from the landing place, where several cases still remained, and to keep an eye on a possible fresh outbreak at the observatory. But the wind was blowing strongly and it was impossible to do any good in the open. Flour and provisions were hurriedly placed in the boat and as much as possible from the tents was taken out on to the foreshore to be covered with a wet tentfly if the worst happened. Luckily it did not. The continuous wet weather had so saturated the bush that no fire could touch it, and almost as quickly as it had started the worst of the blaze died out. It was not, however, for several days that the last traces of the conflagration were extinguished, for the peat once dry continued to burn below the surface, flaring up at intervals as it reached some scorched tree. The fire had evidently started in the large case in which the straw packing had been placed, and in which the large dark slide of the concave grating spectrograph had travelled.

The total damage done was the burning of a few empty cases, which were replaced before we left. The clearing of the scrub and grass made the work of erecting the instruments easier, but also by exposing the soil helped to cause the appalling quagmire in which we had to paddle for the rest of our time at Port Davey.

The first instruments erected were Mr. Worthington's small equatorial, and the Steward equatorial (Plate 14) which, however, was blown over in a hurricane just as it had been adjusted to its final position, and before the holes down to the rock in which its tripod legs rested could be filled in.

The siderostat and coelostat were then erected (Plates 15, 16, 17, 18, 19) and the other instruments placed in rough position. Owing to the incessant storms the mirrors could not be put in until the 27th and 28th April, when a slight lull, with occasional glimpses of sunshine, was taken advantage of. Not until May 6th did we have another fine day, and all our adjusting was done in the short intervals between clouds. On the 6th and 7th, however, we had brilliant days, and all the instruments were finally adjusted and ready for the eclipse. Drills were gone through at frequent intervals both separately and all together. On the 6th some photographs were taken with the concave grating spectrograph, and these were the only trial results we were able to get during the whole of our stay. Mr. Short, who had arrived during a hurricane on May 1st, when the *Wainui* had had to shelter in Schooner Cove for nearly 24 hours, was feeding his principal instrument with the light from the siderostat (Plate 20), as no large equatorial could stand the gales. His equatorial mount was used for his telephoto camera and for Mr. Worthington's Steinheil camera (Plate 21). As will have been gathered, the weather experienced was such that it was with the greatest difficulty that any work could be carried on. On three nights only could Messrs. Brooks and Young obtain star readings. On more than half the days we were at Port Davey a gale was blowing, usually from the west, but varying to the north. On one occasion only did we have a strong wind from the south; and never from the east. The latter direction also gave us less rain than the others. On the rare occasions when we had a fine day there was usually a hurricane which kept the instruments in continuous vibration. To protect them we had to erect wind screens on every side about 4 ft. high, and constructed of posts hammered down to the rock, and joined by ropes at top, bottom and middle, through which brushwood was fixed. Near the siderostat and coelostat canvas was used so as to minimise the danger if the screen broke loose (Plates 22, 23, and 24). It was necessary, in addition to stay ropes, to put struts in at frequent intervals, and even then continual attention was required to keep the thing from carrying away. Enormous benefit was derived from the protection, and the labour of cutting and shaping about 100 posts and conveying them to the site was well repaid by the steadiness of the instruments. Another difficulty due to the weather was the mud that formed wherever the ground was much used. Inside the wind-screens was a veritable morass, often over the boots, in spite of draining. To improve this state of things brushwood was laid on the ground to walk and stand on, but had to be continually added to as it sank into the mire. Added to this the least movement in the neighbourhood caused all the instruments to quake—even the siderostat and coelostat with their foundations of concrete. The instruments were all kept as low as possible so as not to catch the wind, but there was danger in carrying this too far—for in avoiding the wind we got involved in the mud, and in taking a mean between the two we suffered from both. In spite of every care, and quantities of grease, rust began to show on the instruments. We were between the devil and the deep sea. If we ran our clocks, rain got into them, and if we did not, we had no hope of success. No waterproof seemed to be able to keep the water out. The cloth of the slide-holder in the spectrograph tried to peel off. The mirrors commenced to fog, but we had to continue.

On May 8th the weather broke again, and we only succeeded in getting a few drills during the morning. The drizzle which set in during the afternoon turned to steady rain in the evening, which never ceased until the following evening, when the eclipse was past. The dark slides were filled at night and left in the dark tent wrapped in oiled cloth and packed in boxes, until after lunch on the 9th; they were then taken up in the pelting rain and deposited in the instrument tent. The water was drained off the cloth-covered tubes by a rubber pipe leading outside the wind-screens, but by the end of totality there were again deep pools on all the instruments, and there they were allowed to remain till these were dismantled. Half an hour before totality the instruments were got ready as far as possible, and the observers took up their respective positions. Our programme had been to have "the 15 minutes before" called by Mr. Young at the chronometer, and also the "ten minutes" for clock winding, the "two minutes" for placing slides in their holders, and the "one minute" for opening the slides. After that it was intended that he should call the 42 seconds, 16, 9, 4, and 1 by the cusps which would at those times subtend angles of 90°, 60°, 45°, 30°, and 15°. For this purpose Mr. Worthington's 3-inch aperture visual telescope would have been used and the image of the crescent thrown on a sheet of cardboard behind the eyepiece.

Mr. Brooks would call the "Start" by view, and Mr. Young would then take up the seconds from 1 until 210 or whenever Mr. Brooks called "Stop." During this time all would work on their prescribed programmes, which are shown later on in the description of the instruments. After the eclipse was over all dark slides were to be taken direct to the tent, and everyone was to write an account of the eclipse. At the last moment, when everything was seen to be hopeless, I directed that at all instruments only one exposure should be made, starting at 5 seconds and finishing at 200. This would save the slides from damage and would also increase the chance of results if there happened to be a small break in the clouds.

The preliminary calls were given by Mr. Young at the chronometer. The darkness was considerable, but not enough to make action difficult. "Go" was called, and at the "5 seconds after" everyone exposed a plate. Far down on the western horizon was a streak of brightness that moved gradually up the sky. At about 200 seconds a rush of light came up from the west, racing across the clouds, but it was impossible to say when it reached us. The rain still poured down and the eclipse was over—and we were at liberty to dismantle. The dark slides were taken to the tent and the plates thrown away into the bush, except those of the De la Rue and Mr. Winkelmann's telephoto. These were kept in hopes of obtaining a snap of the crescent sun before it sank below the horizon, but nothing resulted, although a faint glimpse of what was probably a portion of the sun showed through the clouds. Across the harbour was a path of light, but it never reached us, and it faded away at sunset. Mr. Short gives a description of the eclipse as follows :—

"Approaching the time of total phase the sky was overcast by nimbus clouds, raining lightly but steadily. The colour of the surrounding landscape was bluish-grey. At 130 seconds after the commencement of the total phase a light break in the clouds showed in the south-west (light Naples yellow in colour) and gradually extended across the sky from S.W. to N.W. At 180 seconds after commencement of total phase a general brightening developed suddenly, and continued fitfully until the end of totality. This fitful brightening towards the end of the total phase was probably due to the varying density of the clouds, and is supported by the fact that the rain ceased soon after the ending of the total phase, and to a hazy sun being seen later through the thin clouds and through the break in the clouds above mentioned. As the sun again became hidden by the stratus clouds in the western horizon a faint green colour developed in the cloud breaks, which gradually faded as night developed."

The work of demolition began at once. The barricades were removed and the easily moved parts of the siderostat and coelostat. Till late on a lovely starry night we continued, and again the whole of the following day, often in pouring rain, and on Wednesday morning, when at 12.30 the instrument tent which had lasted out in spite of everything was struck and taken down to the shore. Instead of carrying the cases we used a rough sledge, made by Mr. Dowsett, which saved endless labour, as several cases could be taken at one trip by 4 or 5 persons (Plate 29). The two miners had returned and rendered us invaluable assistance. We chose a new spot for our embarkation which was more sheltered from the wind than our original landing place, and there we left the cases damaged and mud-stained till the *Wainui* came in (Plate 30).

The *Wainui* was expected on the night of the eclipse on its way to Hobart, but did not arrive till the following morning, when it brought us the sad news of King Edward's death. Mr. Worthington left on it with letters and telegrams, but we had arranged to leave when it returned en route for Melbourne. This was likely to be on the evening of Wednesday, the 11th, so having finished at the observatory we set to work striking our camp, leaving only the dining tent till the ship appeared, and the cookhouse which was being left behind. It was lucky we did so, for the ship did not arrive until the following morning. In the meantime we spent the night partly in the tent, but mostly around a big camp fire, as the night was fine except for a shower or two after 5 a.m. At daylight we struck the last tent, and had almost finished filling the boat with its first load, when the *Wainui*, under Captain Brown, who had relieved Captain Livingstone, came to anchor at 8 a.m. From then till 10.45 we were busy, and by midday were leaving the spot where we had worked in rain and mud for over a month on perhaps the most inhospitable coast that exists on an habitable land. We left without regrets (Plate 31).

On board we learnt of the equally disappointing experience of the Bruni island expedition; how at Zeehan and Strahan the partial phase had been seen in a clear sky, but not totality. How Queenstown, up in the mountains above Macquarie harbour, had seen it all, and was probably the only place that had done so. Later I was lucky enough to obtain some photographs of the corona from the Rev. L. S. Macdougall and Mr. J. Booton, taken with a Thornton Pickard half plate camera with the back combination of the lens removed, giving a quarter inch image, and extremely good for so small a camera and without clockwork. The exposures were about 2 seconds, and the stop F 22, and the plates used were Imperial Special Rapid. My very best thanks are due to them for their kindness in letting me have the negatives, a description of which is given in Chapter VI. We called in at Strahan the following day, a rough sea and a swift tide delaying us for some hours from entering the dangerous "Hell's Gates" that prevent Macquarie harbour from becoming a great port. Here Wilson left us to return to Hobart.

Leaving again the following day, we arrived in Melbourne on the night of Sunday, May 15th, and the following two days were spent in unpacking the instruments and drying, cleaning, and greasing them. The tents were laid out in a warehouse, as they too were soaking wet. Finally on Wednesday, May 18th, Messrs. Brooks, Winkelmann, Short, and Jeffs left for Sydney and Auckland, taking with them some of the instruments which will be required at Vavau, and the tents which, after being repaired, will also be required there. On the same day Mr. Worthington sailed for England on the *Orvieto*, and the following week Mr. Dowsett left for Durban, and Mr. Young and myself for England on the *S.S. China*.

So ended a most melancholy eclipse without any visible results, but with a store of useful experience much of which will doubtless come in very handy in the future, and much of which I hope will never be needed again.

An extract from the *Sydney Mail* may not be out of place here. Their Queenstown correspondent writes with reference to his experiences at that place.

"On the day of the eclipse, heavy, lowering clouds enveloped the mountains, and hung down to the foot hills, so that even much of a familiar landscape was not visible. But, as if by appointment, a rift appeared, and quickly the grey gave place to bright blue, and the sun descended into it like a jewelled ship gliding into a calm sea. What a rush there then was for smoked or coloured glasses, which had been put by in the belief that they would not be required. It was all so unexpected that it came as a sudden and delightful surprise. There had been no wait, no anxiety as to whether this, that, or the other thing would transpire. It was simply the turning of an anticipated disappointment into a complete realisation. The unfortunate part about it was that cameras had been left at home by those who had made elaborate preparations. Still, there were some who had their 'picture-takers' with them, but very few have since been reported as having obtained good results ; probably the occasion was too much for them, and they became too flurried."

There is an account of the eclipse given by Mr. E. Carns Driffield, M.Aust.I.M.E., superintending engineer of the Mount Lyell railways, which has not previously appeared in print :—

"Even as late as three o'clock in the afternoon, although the rain had then ceased, the outlook was hopeless, but a friend and myself decided to climb to the top of the Flux Quarry Hill and chance our luck, as it were. The prospects were too gloomy to even take any instruments with us, and the theodolite and even the smoked glass were left behind. We arrived at the top of the Quarry Hill about 3.20 p.m. and were most agreeably suprised to see the western sky rifting into broken cloud line, with every appearance of improvement to follow. Our hopes began to rise to higher pitch as the light became stronger, indicating greater tenuity in the cloud veil, and in less than a quarter of an hour we could just see the hazy outline of the sun through the clouds, with about six digits, or nearly half the face from the western limit eclipsed. Just then we were (very fortunately for us) swelled by the boisterous advent of about a dozen school children all equipped with coloured or smoked glass and copy books. We gladly availed ourselves of their generous offer of the use of their glasses. With all my instruments ready adjusted lying uselessly in my office in the valley below, the situation had its lesson even to our maturer years. The clouds became more detached and tenuous, and by 3.45 we were able to obtain occasional glimpses of the sun quite unobscured. Although about two-thirds of the disc was then eclipsed there was very little perceptible diminution in the daylight, which I attribute to the fact that the forenoon of the day had been so clouded and dark that the dispersing clouds and brighter sun, although with less light, had its compensation. At this stage a fine open rift appeared in the drifting clouds just below the sun, about 20 degrees long and 8 or 10 degrees across, and we hoped enthusiastically that totality would occur in this space. And as if by a miracle it did. Slowly the sun descended out of the cloud banks into this space, bursting into full view about 4.5. The sight from this out to the end of totality, and for some time afterwards, was absolutely unobscured and perfect, and never shall I forget the grandeur of it all. Steadily the light diminished as the moon's black disc gradually enveloped the luminous crescent, now but one digit in breadth. In appearance this crescent was like a quivering, molten bath of quicksilver, and seemed to scintillate with prismatic rays of light. The eastern limit of the sun was gradually reduced to a glowing crescent band and totality ensued about 4.15. At this supreme moment the sight was too enthralling to fully absorb and realise, much less to permit of any adequate description being attempted. The gaunt, fire-swept hills of

Queenstown, with their black peat covering, quivered in an awesome light; and the great mass of cloud horizon below the sun glowed with indescribable tints and hues. The denser masses of cloud showed mainly in purple tints, while the more tenuous rifts among them blazed with salmon and orange light like a myriad of subterranean fires. The sepias of the hills were tinted with spectral colours not to be described, and only to be seen to be understood. The air felt distinctly colder, and the darkness was equal to a medium twilight. Faces looked pale and ghostly, and the situation was weird in the extreme. A solemnity fell upon the little party.

"We were too engrossed with the scene to observe times correctly, and I questioned whether totality lasted more than two minutes. In that brief interval how eagerly we drank in the ravishing splendour before us. The moon's disc appeared in an immense black circle in the sky, set in an azure blue lake, surrounded on all sides by cloud banks, each exhibiting a colour scheme of entrancing glory. Encircling the moon's disc, intensely black, was the beautiful pulsating chromosphere of the sun, emitting fluctuations of yellow and orange-coloured flame-like rays, from which streamed in all directions rays of multi-coloured light, delicate pink and orange predominating. From the eastern limb, on the upper half particularly, long streamers, flexing strongly to the north, were observable all through totality. The streamers from the western limb were much shorter and of more uniform length. Without even the aid of a field-glass, one's whole being was wrought with vexation at the inability to pry more closely into these wonderful shafts of light.

"While wrapt in silent contemplation of the majestic grandeur before us, totality ended, and an apex of brilliant dazzling light shot suddenly from the sun's western limb on its lower half just as if a gigantic arc light had been suddenly switched on. Having watched the moon's disc gradually moving off the face of the sun now setting behind the horizon clouds, we turned our steps homeward filled with mixed feelings of joy at the good luck which had attended us, and of solemnity at the majesty of the scene which will never be effaced from my memory."

CHAPTER IV

DESCRIPTION OF INSTRUMENTS

THE observing instruments were, as has been previously mentioned, sent out direct to Hobart by the *Ionic* belonging to Messrs. Shaw, Savill, and Albion, and consisted of the following (Plate 32) :—

21 inch siderostat.
16 inch coelostat.
16 foot coronagraph.
8 foot coronagraph (De la Rue).
10 foot concave grating spectrograph and 31 feet 6 inch focus O.G.
42 inch transparent grating spectrograph.
48 inch Steward equatorial.

Also from Sydney, Mr. Short brought a double coronagraph consisting of a 5 foot camera and a telephoto of about 10 feet equivalent focus, and also had with him a small telephoto of about 6 feet equivalent focus. Mr. Winkelmann brought his telephoto camera which he had used at Flint Island, and Mr. Worthington brought with him a Steinheil camera of $2\frac{3}{8}$ inch aperture mounted equatorially, and a visual telescope of 3 inch aperture and 40 inch focus.

In addition to the above, it was necessary to take many other instruments for the laying out and adjusting of the main instruments.

6 inch Troughton and Sims theodolite (Mr. Brooks).
4 inch Cooke theodolite.
Sextant with Mercury horizon and mounting.
Pocket sextant (Mr. Brooks).
Chronometer by Kullberg (Sydney Observatory).
$1\frac{3}{4}$ inch telescope—possible for cusp work.
6 inch plane mirror, by Common, and mount (Solar Physics Observatory, S. Kensington).
Plane mirror 10 inch $\times 6\frac{1}{2}$ inch and mount.
Oval plane mirror $4\frac{7}{8} \times 3\frac{3}{8}$ inches and mount.
Oval plane mirror $3\frac{5}{8} \times 2\frac{1}{2}$ inches and mount.
2 Abney levels.
1 Prismatic compass.
2 Carpenter's levels.
1 Steel tape.
1 tape.
3 Two-foot rules.

Besides camel hair brushes, set squares, chamois leather dusters, knives, black eyes, paste, adhesive plaster, etc., which should properly come into the list of general stores.

The photographic plates taken were in excess of the quantity required for the eclipse, and were packed in cardboard boxes containing six each. They were not packed in airtight cases, but simply in wooden boxes with shavings, which were again in one of the large cases. They were divided into two lots, so that if anything went wrong with one the other would remain good. The following is a list of plates taken:—

24	films	$12 \times 3\frac{1}{4}$	Barnet Superspeed Ortho.
12	Plates	$12 \times 3\frac{1}{4}$	Wratten Wainright.
12	,,	10×10	Mawson and Swann-Castle.
6	,,	10×10	Imperial Special Rapid.
12	,,	6×6	Barnet Superspeed Ortho.
12	,,	6×6	Mawson and Swann-Castle.
12	,,	6×6	Imperial Special Rapid.
48	,,	$5\frac{3}{4} \times 5\frac{3}{4}$	Barnet Superspeed Ortho.
12	,,	$5\frac{3}{4} \times 5\frac{3}{4}$	Mawson and Swann-Castle.
12	,,	$5\frac{3}{4} \times 5\frac{3}{4}$	Imperial Special Rapid.

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21 INCH SIDEROSTAT.

Built by T. Cooke and Sons of York, 1907.

Previously used at Flint Island.

Packed in 10 cases (heaviest about 3 cwt. including case).

(Plates 15, 16, and 17.)

A concrete foundation was laid 4 feet square and about 12 inches thick and with its upper surface level with the ground. This was, if anything, on the small side in the N. and S. line. The two base plate supports were fixed in position with cement, and the base itself was swung into position by means of shear legs as also was the arc. Before the mirror pillar was fixed, the ball bearing was placed on the vertical screw through the bottom, which was not screwed up to its proper height until the mirror fork was in position.

The polar axis was then placed roughly in the correct latitude and fitted to the mirror cell.

The counterpoise weights were hung on their rods but not pinned in position until the mirror was placed in the cell (April 28).

The clock was put in and driven by three weights over a gallows and was first rated against a watch with an allowance for the solar movement, as it was too cloudy to follow with an image.

A special covering of Willesden canvas was made to protect the clock but could not be used when this was running. A rough shelter of the same material was also used, but failed to keep out all the rain which poured in a stream down the driving rod.

Over the mirror, which has a plate glass cover, was laid a strip of oiled Japara, and over the whole instrument a cover of Willesden canvas.

In spite of this, and a copious use of oil and vaseline, everything became rusty and the mirror badly fogged. The glass cover to the mirror was removed at every possible moment of fine weather to prevent the moisture from condensing inside.

A difficulty was experienced in driving the instrument as late as the time of eclipse, owing to the roller grooves in the mirror axis not being of sufficient length. This was got over by adding an additional drive to the mirror arm direct when a perfectly steady movement was obtained. This difficulty is being seen to by Messrs. Cooke & Sons, in case the instrument is again required to work under such abnormal circumstances.

The siderostat was not run with an image until May 1st, owing to the entire absence of sunshine, and when finally there was continuous sun on May 6th, it was found to be correct.

S. G. Dowsett was put in charge of the instrument to see to the clock and work the slow movements in R.A. and Dec. if found necessary—directions being called to him by F. K. McClean who was using a $3\frac{1}{3}$ inch image and could therefore detect the slightest error in movement.

The height of the centre of the beam was 39 inches above the concrete bed.

The siderostat fed of the following cameras:—

8 foot De la Rue coronagraph.
10 foot concave grating spectrograph.
Short 5 foot coronagraph.

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16 INCH COELOSTAT.

Lent by the Government Grant Committee.

Packed in 5 cases.

(Plates 18 and 19.)

A concrete foundation was laid 3 ft. N. and S. by 2 ft. 6 in. and about 12 ins. thick to the level of the ground. On this was placed a packing case filled with stones, and on the top again was the coelostat. Strips of metal were used to base the levelling screws on as no base plates were with the instrument. There were four of these screws which made the levelling difficult. The adjustment for latitude was made before the mirror cell was attached, but there was no slow motion screw to place it accurately. The mirror cell and polar axis were put up with the drive at the top, and the clock was fixed on a separate pillar. Considerable difficulty was at first experienced in driving the clock at the requisite speed, but by reducing the number of pulleys from 4 to 2, and staying the gallows against the diagonal pull of the clock wire this was accomplished, but part of the quadrant was irregular. The mirror was in position on April 27th, but the metal cover did not fit well. The whole was covered with Willesden canvas and the mirror had a piece of oiled Japara in addition. The clock had a separate cover.

The mirror tarnished badly and became bright red with the moisture. It also peeled off in spots in spite of the greatest care. This may have been partly caused by the fact that it was not sealed up for the voyage out. There are no marked positions on the instrument, so that it was impossible to have it ready for the eclipse without a glimpse of the sun beforehand, and this would have caused considerable trouble if the clouds had cleared off during totality.

J. Brooks was in charge of the erection and adjustment of the coelostat, and would have finally prepared it for the eclipse before going to the 16 foot coronagraph when H. Winkelmann, whose instruments were alongside, could do anything that was necessary. At the last moment, when the rain was pouring down, H. Winkelmann left his own work and stood ready to uncover the mirror and clamp it in position should a glimpse of the eclipse appear, and thus enable some result to be obtained with the 16 foot. The coelostat fed the following cameras :—

16 foot Cooke coronagraph.
42 inch transparent grating spectrograph.
Winkelmann telephoto camera.

And also the Steward equatorial tube, whose mounting had been damaged by a fall.

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16 FOOT CORONAGRAPH.

Operated by J. Brooks.

Previously used in Spain in 1900 *and in Majorca in* 1905.

(Plate 24.)

The object glass was a 4 inch Cooke photo visual giving an image of $1\frac{3}{4}$ inches diameter. The camera consisted of 3 square wood frames joined at each corner by wooden battens 8 feet long, and the whole covered with black Italian cloth. Into the front frame the object glass was screwed and a sliding piece gave the necessary focus, which, however, had been previously determined in England. In the back frame there was a holder for the ground glass and dark slides. The instrument was supported on three wooden trestles and was fed from the top left portion of the coelostat beam. It was placed in the azimuth of sunset.

The following were the arranged exposures and plates :—

2 seconds	to	20	Mawson Swan "Castle" plate.	Exposure	18 seconds.
30 ,,	,,	125	,, ,, ,, ,,	,,	95 ,, .
135 ,,	,,	195	Imperial Special Rapid ,,	,,	60 ,, .

The plates were ten inches square.

These exposures were not followed as, at the last moment, directions were given to expose the first plate at 5 and close at 200.

8 FOOT DE LA RUE CORONAGRAPH.

Operated by A. WILSON.

(Plates 22 and 23.)

Previously used in Novaya Zemlya, India, twice in Spain, and at Flint Island.

The object glass was $4\frac{5}{8}$ inches aperture and 8 foot focus. The body of the camera was a strong wooden tube with a slide end for the lens on which the focus had been previously marked. A wooden shutter was hinged above the lens and was worked from the plate end by a cord, thus obviating the necessity of any movement on the part of the operator.

It was supported on two heavy packing cases, to which it was securely roped and kept in position by long guide nails. It received its light from the top right portion of the siderostat from which its distance was 44 inches.

The arranged exposures and plates were as follows :—

2 seconds	to	35	Barnet Superspeed Ortho plates.	Exposure	33 secs.
45 ,,	,,	100	Imperial Special Rapid ,,	,,	55 ,,
110 ,,	,,	155	Barnet Superspeed Ortho ,,	,,	45 ,,
165 ,,	,,	205	Mawson Swan "Castle" ,,	,,	40 ,,

The plates were 6 inches square.

The exposures were not followed out, but the first plate was exposed from 5 seconds to 200 seconds.

10 FOOT CONCAVE GRATING SPECTROGRAPH.

Operated by F. K. McClean.

(Plates 25, 26, 27 and 33.)

This instrument, which was fed from the top left portion of the siderostat, had a 6 inch aperture Cooke photo visual object glass of 31ft. 6in. in focal length. This was mounted in a heavy cast iron frame on 3 levelling screws, and placed on a packing case at the necessary height. At the focus of this lens was a 2 inch slit by Adam Hilger which was screwed into the wooden camera. The concave grating was 10ft. focus and had 14,438 lines to the inch, having been ruled by Schneider with a Roland engine in 1889. The ruling was $3\frac{3}{8}$ inches by $1\frac{7}{16}$ inch on a four inch square plate. The dark slide held 6 films, each 24 inches long and $3\frac{1}{4}$ inches wide, but, owing to the difficulty of obtaining reliable flat films of this length two were used in each case 12 in. long, and butting against one another. The slide was put in at the top of the holder and dropped down until the lowest film was a little above the level of the camera opening, after which it was worked by a ratchet with a catch at each exposure. As the whole of the slide front was opened at once it was necessary to have the holder of sufficient height to cover the films both when above the camera and below it.

A certain amount of focus was obtained by a sliding box held by thumb screws.

The camera body was all of wood covered with black Italian cloth and protected from the weather by a large Willesden canvas sheet. It had been constructed and put together at South Kensington, and all the parts carefully marked so that there was no difficulty in erecting it on the ground. Between the slit holder and the grating was a solid wooden tube with a length cut out of one side through which the reflected beam passed along a built up tube to the dark slide.

No difficulty was experienced except that of finding the exact length of so long a focus, and on May 6th, the first of our two really fine days, a couple of photographs were taken of 10 seconds and 8 seconds respectively with good results. It was, however, found impossible to work the slow motions from so great a distance by cords, and this was arranged to be done by S. G. Dowsett at the Siderostat.

The arranged exposures were:—

9	secs.	before totality, snap.		
3	,,	,, ,,	snap.	
2	,,	to 100 secs.	Exposure	98 secs.
103	,,	,, 200 ,,	,,	97 ,,

This was not, however, followed out, and one exposure only was made.
The films were Barnet Superspeed.

42 INCH TRANSPARENT GRATING SPECTROGRAPH.

Operated by H. WINKELMANN.

Previously used at Majorca in 1905, *and Flint Island in* 1908.

In front of the 4 inch object glass was placed a transparent Thorpe grating of 17,000 lines to the inch, giving a visible spectrum of about 10 inches. The body was a wooden box, and the light was supplied from the Coelostat reflected by a plane mirror 10 inches long and $6\frac{1}{2}$ inches across with the corners cut, making it octagonal in shape. The mirror was in a metal cell mounted on a wooden base.

The arranged exposures were:—

2 secs. to 105 secs.	Wratten	Wainwright	panchromatic	plate.	Exposure 103 secs.
115 ,, ,, 200 ,,	,,	,,	,,	,,	,, 85 ,,

No exposures were made with this instrument.

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48 INCH STEWARD EQUATORIAL.

Operated by E. JEFFS.

Packed in 6 cases.

(Plates 14 and 28.)

The object glass is a 6 inch doublet fitted to a telescope tube. This is mounted on a heavy tripod with pillar and equatorial mounting by J. H. Steward of the Strand, London. It was erected and tested at the Solar Physics Observatory before it left England. It was adjustable for latitude and also for the Northern or Southern hemisphere, and had a governed clock attached to the pillar.

At the Eclipse camp it was erected and adjusted, but later, for safety, holes were dug for the tripod legs to stand in. Before, however, these holes could be filled in and rammed, a gale blew the instrument over slightly, bending the polar axis and breaking away the sides of the cotter screw holes by which the R.A. axis is locked to the Declination axis. It would have been possible to have repaired this sufficiently to make use of the equatorial if only the weather had been reasonable, but finally it was considered preferable to use the telescope camera in a horizontal position and feed it from the Coelostat. This was done and the lower left portion of the beam was used. A wooden trestle was erected and levelled out for it in front of and below the 16 foot coronagraph.

The arranged exposures were :—

2 secs.	to 40	secs.	Mawson Swan Castle plate.	Exposure	38 secs.
50 ,,	,, 100	,,	Imperial Special Rapid.	,,	50 ,,
110 ,,	,, 170	,,	Barnet Superspeed Ortho.	,,	60 ,,
180 ,,	,, 205	,,	,, ,, ,,	,,	25 ,,

These exposures were not, however, followed out, but one single exposure was made.

WINKELMANN TELEPHOTO CAMERA.

Operated by H. WINKELMANN.

This was the same camera as was used at Flint Island with very good results. The details of it are as follows :—

$\frac{1}{2}$ plate Ross Camera—Ross Zeiss convertible Protar.
Back lens, 18 inches focus.
Front lens, 9 ,, ,,
Combined lens, $6\frac{1}{4}$,, ,,
Tele negative Ross Zeiss 3 inches focus.
Equivalent focus 5 feet 3 inches ,,

The instrument was fixed on a rough table and fed with light by the Coelostat. The arranged exposures were :—

5 secs.	to 70	secs.	Imperial plate.	Exposure	65 secs.
80 ,,	,, 160	,,	,, ,,	,,	80 ,,
170 ,,	,, 205	,,	,, ,,	,,	35 ,,

No exposures could be made.

WORTHINGTON EQUATORIAL CAMERA.

Operated by J. WORTHINGTON.

(Plate 21.)

The instrument was made by Steinheil and had an aperture of $2\frac{3}{8}$ inch and a focal length of 15 inches. It was mounted on a tripod but later, owing to clock trouble, it was attached to J. Short's telephoto on the equatorial mount brought by him.

The arranged exposures were :—

2	secs.	to	35	secs.	Exposure	33	secs.
55	„	„	130	„	„	75	„
150	„	„	205	„	„	55	„

J. SHORT'S INSTRUMENTS.

(Plates 20 and 21.)

Mr. J. Short, who brought his own equipment from Sydney Observatory, gives the following description :—

"Through the kindness of Mr. J. H. Hogue, Minister for Public Instruction in New South Wales, I was enabled to take part in the Solar Eclipse Expedition to Port Davey on May 9th, 1910. The instruments designed for the occasion were of course governed by the material and lenses available. They consisted of a double coronagraph and a telephoto camera. In one compartment of the coronagraph was a lens 5 inches diameter and 5 feet focal length by Dallmeyer giving a direct image about $\frac{5}{8}$ inch in diameter. The second compartment contained a lens 3 inches in diameter and 47 inches focal length also by Dallmeyer, and an enlarging lens producing a final image of $1\frac{1}{8}$ inch in diameter. To the side of the coronagraph was firmly fixed a small camera carrying a lens 1 inch in diameter and 8 inches focal length, and a telephoto attachment, the equivalent focus of the combination being 5 ft. and producing an image about $\frac{5}{8}$ inch in diameter. The whole was mounted equatorially.

"The stand for the equatorial head was composed of 2 uprights 4 inches square of pine. The base into which the uprights were fixed was formed of 2 pieces 4 inches square by 10 ft. long placed at right angles to each other forming a cross. The piece into which the upper ends of the uprights were fixed extended to the base piece and thus formed a tie north and south. Two pieces 3 in. by 2 in. and several feet in length formed 2 ties, one on the east and the other on the west side of the upright.

"Upon my arrival at Port Davey on the morning of May 1st, I was met by Mr. F. K. McClean, who during the interview remarked upon the high south and south-west winds which had prevailed during their stay, and which would be highly detrimental to mounting my coronagraph equatorially, and suggested mounting it horizontally and feeding it from the siderostat by the aid of a supplementary mirror, and also to use the equatorial head as a mounting for the small cameras which were available. To the above suggestion I readily agreed and finally carried out.

"On the equatorial head were mounted my telephoto camera and a small camera of Mr. Worthington's. Everything was in adjustment two days before the Eclipse, during which time drills were gone through."

TIMEKEEPING DURING ECLIPSE

Operated by A. E. Young.

We only had one chronometer which Mr. Brooks brought from Sydney Observatory. It was by Kullberg and beat $\frac{1}{2}$ seconds. To check this, Mr. Brooks had a very accurately running watch and Mr. McClean a chronometer watch. A description of the chronometer is given in Mr. Brooks' report.

Mr. Young called the seconds during Eclipse starting from 1 and continuing to 210 or such time as Mr. Brooks called stop. Before the Eclipse it was arranged that he should call 42, 16, 9, 4, and 1 second before from cusp readings taken with a 3 inch telescope of Mr. Worthington's. This, however, was impossible, and he took his time from the chronometer illuminated by a small bull's-eye lamp. The electric sounder described by Mr. Brooks in his report was extremely useful, as the beats were distinctly audible for a considerable distance.

CHAPTER V

ASTRONOMICAL DETERMINATION OF POSITION AT PORT DAVEY

The determination of position was worked by Mr. J. Brooks and Mr. A. E. Young, and was accomplished with much difficulty owing to the weather conditions. The following pages give a very full description of the work.

Report by J. Brooks, F.R.A.S., F.R.G.S.

The instruments used at Port Davey (Tasmania) for the determination of Latitude, Time, Azimuth, and, incidentally, Longitude, were:—

(1) A chronometer by Kullberg, No. 4463, beating half seconds (and keeping sidereal time), to which had been added an extra wheel of (originally) 60 teeth. The duty of this extra wheel was to "break circuit" at the beginning of each second, but the tooth representing the 60th second had been removed so that—the circuit not then being broken—there is an interval of twice the ordinary duration, serving to mark and emphasise the "beginning" of the next minute. Thus, after the extra long interval the *first* sound heard when using a sounder, or the first notch seen on the sheet when using a chronograph, is the *end* of the first second in the new minute.

In conjunction with the chronometer a small pony-sounder was used to considerably strengthen the "sound" of the second's beat, a pint bichromate cell supplying the electricity.

(2) A 6-inch Troughton and Simms transit theodolite, each circle being graduated to 10 minutes of arc and read, each by 2 verniers to 10 seconds (and by estimation to 5 seconds) of arc. A small speculum ($\cdot 25 \times \cdot 2$ in.) of silver fixed to a small annular clip and mounted on the outside of the object-glass reflected the light from a bull's-eye lamp, held in the hand, down the tube of the telescope, thus giving dark wires on a bright field.

The chronometer (Kullberg, No. 4463) was lent to the expedition by Mr. W. E. Raymond (in charge of the Sydney Observatory) with the consent of Mr. R. Macdonald, Under-Secretary for Lands, to which department it actually belonged as part of the equipment of the Trigonometrical Survey. It was "fast 8·9 seconds at noon, March 7th, 1910, with a *then* average daily losing of 2·86 seconds."

Owing to almost continuously cloudy weather, astronomical observations were of a decidedly intermittent character, so probably it would be better to detail operations in chronological order.

As a preliminary the magnetic meridian was determined from the site of the siderostat, and then applying an approximate value of the magnetic declination (E 9° 0′) the true meridian was obtained near enough to build concrete foundations for siderostat and coelostat. The observations were as follows:—

Using *North* end of needle in "trough compass" and vertical circle to right hand—then the bearing of the highest clump of timber on Davey Hill was observed.

In the next step the *South* end of the needle was used, of course the vertical circle remaining on "right hand."

Then the needle was reversed—turned end for end—in the trough and, of necessity, the theodolite turned through about 180°, thus bringing the vertical circle to "left hand." As before first the north end, and then the south end, of needle was made to coincide with its own fiducial mark on the trough and a third and fourth reading taken to clump of timber on Davey Hill.

The following are the observations:—

				Mean.
N. end.	Circle R.	Clump of timber on Davey Hill	275° 50′	275° 51′ 30″
S. do.	„	do.	275 53	
N. do.	Circle L.	do.	276 14	275 54 30
S. do.	„	do.	275 35	

Final mean magnetic bearing of top of highest clump of timber on Davey Hill was 275° 53′ 0″.
Approximate true bearing of same was 284° 53′ 0″.

(*Note.*—In all cases bearings are read from North, through East, South, and West back to North, following practice which is probably universal amongst Surveyors in New South Wales.)

For convenience and comfort it was decided to make the Astronomical observations from a peg just outside camp about 25 chains due east of the site of the siderostat on Observatory Hill, and then to carry on the bearing so obtained to wherever wanted. The readiest way to do this was to put down a peg on Hammond Point, from which both Camp and Observatory could be seen.

Just before dusk on April 18th, 1910, the magnetic bearing of the peg on Hammond Point from Camp peg was found—in the same way as just described—to be:—

$$\left.\begin{matrix}179^\circ\ 20' \\ 179\ \ 47\end{matrix}\right\}179^\circ\ 33'\ 30'' \quad \text{and} \quad \left.\begin{matrix}179^\circ\ \ 8' \\ 179\ \ 26\end{matrix}\right\}179^\circ\ 17'\ 0'',$$

final mean being 179° 25′ 15″.

The theodolite was covered and left standing over Camp peg until next morning (April 19th), when again the magnetic bearing of peg on Hammond Point was determined—the results being:—

$\left.\begin{matrix}179^\circ\ 32' \\ 179\ 26\end{matrix}\right\}179^\circ\ 29'\ 0''$ and $\left.\begin{matrix}179^\circ\ 18' \\ 179\ 39\end{matrix}\right\}179^\circ\ 28'\ 30''$. Mean $179^\circ\ 28'\ 45''$.

Final mean of evening and morning observations, 179° 27′ 0″.

Using the approximate value of the Magnetic Declination E. 9° 0′, the "true" bearing of peg on Hammond Point was taken as 188° 27′ 0″, or, in other words, the true meridian was S. 8° 27′ E. of peg on Hammond Point.

April 19th, 1910—Evening.

For the present it was assumed that Chronometer Kullberg No. 4463 had maintained a uniform daily losing rate of 2·86 seconds, and that the Longitude of Camp peg was 9h. 44 m. 0 s. E. of Greenwich; that is, that Camp peg was 20 m. 49·54s. *West* of Sydney Observatory. In the interval from March 7th, 1910, to April 19th, 1910, the Chronometer lost 1 m. 54·1 s. so that it was, in round numbers—18 m. 55 s. on local sidereal time at Camp peg.

Peg on Hammond Point having been made to read 188° 27′ 0″—true South was at, or about, 180° 0. So as to get an approximate idea of the proper reading to "true South," Star v Octantis was followed at its lower culmination—by turning the *upper* plate of the theodolite (and keeping the star as nearly as possible on the middle wire) until the Chronometer indicated 10 h. 33 m. 30 s. (that is R.A. 22 h. 14 m. 35s. + 18 m. 55 s. − 12 h. 0 m. ·0 s. for Lower Culmination), and then the horizontal circle read 179° 45′ 50″. The instrument remaining at that reading, the Upper Culmination of θ Argus was noted by Chronometer at 10 h. 58 m. 29·5 s.; whereas, had the instrument been exactly in the meridian, the transit would not have occurred until 10 m. 58·41 s. by Chronometer (*i.e.*, R.A. 10 h. 39 m. 46 s. + 18 m. 55 s.). As the clock rate was at present uncertain, it was considered that 179° 45′ 50″ was near enough to the meridian reading for Latitude observations.

The Zenith distance of θ Argus when crossing the meridian was noted as 20° 37′ 10″, and at 11 h. 4 m. 1·5 s. by Chronometer the Zenith distance of ν Hydrae was observed as 27° 36′ 50″. These two observations gave the latitude thus :—

	θ Argus (S.)		ν Hydræ (N.)	
Z. D. obsd.	20° 37′ 10″		27° 36′ 50″	
Refn.	+ 22		+ 30	
Z. D. true	− 20 37 32		+ 27 37 20	
Decn.	− 63 55 38		− 15 43 29	
Latitude	− 43 18 6		− 43 20 49	
		Mean Latitude	43 19 28	of Camp peg.

The first Astronomical observations on April 19th, 1910, were for Azimuth, the stars used being α Apodis and γ Hydri as follows :—

α Apodis (R.A. 14h 36m 43s δ − 78° 39′ 51″).

	h. m. s.		
at	10 3 21·5	Z. D. 44° 23′ 20″	Hor. Cir. 164° 11′ 30″
,,	5 33	,, 44 17 0	,, 164 12 20
,,	8 57	Alt. 45 55 30	,, 344 13 20
,,	10 54	,, 46 1 0	,, 344 14 0
mean	10 7 11·4	Z. D. 44 10 57·5	Hor. Cir. 164 12 47·5
		r + 56·5	

true Z. D. (z) = 44 11 54·0
*P. D. (p) = 11 20 9
Co. lat (c) = 46 40 32

2.S = 102 12 35

S =	51 6 17·5	cosec	0·1088550
S − p =	39 46 8·5	sin	0·1940276
S − z =	6 54 23·5	sin	9·0800849
S − c =	4 25 45·5	cosec	8·8877804

$\tan^2 \frac{A}{2}$ 18·2707479

$\tan \frac{1}{2}A =$ 9·1353740

7 46 37·6 = $\frac{1}{2}A$

15 33 15·2 = A
164 12 47·5

179 46 2·7 using Z. D^s.
179 46 14·2 ,, hour angle.
(computations not given).
179 46 8·4

γ Hydri (R. A. 3h 48m 34s δ − 74° 31′ 1″).

	h. m. s.		
at	10 20 13·5	Alt. 40° 37′ 0″	Hor. Cir. 20° 18′ 20″
,,	,, 23 39·5	,, 40 24 30	,, 20 12 40
,,	,, 26 38	Z. D. 49 50 20	,, 200 9 20
,,	,, 28 58	,, 49 59 30	,, 200 5 20
mean	10 24 52·2	Z. D. 49 42 5	Circle 200 11 25
		Ref. + 1 9	

true Z. D. (z) = 49 43 14
*P. D. (p) = 15 28 59
Co. lat (c) = 46 40 32

2.S = 111 52 45

S =	55 56 22·5	cosec	0 0817350
S − p =	40 27 23·5	sin	0·1878417
S − z =	6 13 8·5	sin	9·0347468
S − c =	9 15 50·5	cosec	9·2067832

$\tan^2 \frac{A}{2} =$ − 18·5111067

$\tan \frac{A}{2} =$ 9·2555534

10 12 37·6 = $\frac{A}{2}$

− 20 25 15·2 = A
200 11 25·0 = Circle reading.

179 46 9·8 using Z. D^s.
179 46 13·0 ,, hour angles.

mean 179 46 11·4

Final mean true South reading, 179° 46′ 10·0″ (say).

Reverting to the Magnetic observations—assuming that the Magnetic Declination was 9° 0′ E.—the peg on Hammond Point was made to read 188° 27′ 0″ (179° 27′ 0″ + 9° 0′ 0″). Had this assumption been verified, or justified, the reading to true South would have been 180° 0′ 0″ (this was as a convenience) and Magnetic South would have read 189° 0′ 0″.

But the preceding computations indicate that the correct reading to true South was 13′ 50″ less than 180°. Therefore the real Magnetic Declination is E. 9° 13′ 50″, in other words the difference between 179° 46′ 10″ and 189° 0′ 0″ is the Magnetic Declination at that date: 19 April, 1910.

A peg was put down on Observatory Hill in a convenient position, and the angle between that peg and the Camp peg *at* the peg on Hammond Point, was measured three times, the results being, 64° 2′ 15″, 64° 2′ 30″ and 64° 2′ 5″, giving a final mean as 64° 2′ 17″.

True bearing of Camp peg from peg on Hammond Point	... ...	8° 40′ 50″
Angle between " and " Observatory Hill	... ...	64 2 17
True bearing of peg on Observatory Hill from peg on Hammond Point	...	304 38 33

Setting up the theodolite over peg on Observatory Hill and using the "back" bearing 124° 38′ 33″ the true meridian passing through centre of site for siderostat and coelostat was indicated by pegs at these centres and by pegs North and South of each. In addition a peg was put down showing the direction that the 16 ft. camera was to be in on May 9th, 1910.

The next clear night was on April 22nd, when the following observations were made for clock error.

β Orionis. W. of Meridian.

	°	′	″		h. m. s.	
Z. D.	59	0	0	at	9 7 42·5	by Chron^r.
"	59	10	0	"	8 41	"
"	59	20	0	"	9 41	"
Alt.	30	20	0	"	11 40	"
"		10	0	"	12 40·5	"
"		0	0	"	13 40·5	"
Mean Z. D.	59	30	0	"	9 10 40·9	"

β Orionis R. A. 5h 10m 11·8s $\delta - 8° 18′ 22″$

	° ′ ″		
obs^d Z. D. =	59 30 0		
Ref^n. +	1 39		
true Z. D.	59 31 39		
$90 - \phi$	46 40 32		
$90 - \delta$	81 41 38		
	187 53 49		
S =	93 56 54·5	cosec =	0·0010320
$S - 90 + \phi$	47 16 22·5	sin	9·8660474
$S - 90 + \delta$	12 15 16·5	sin	9·3268596
S − Z. D.	34 25 15·5	cosec	0·2477449

$\tan^2 \frac{t}{2} = 19·4416839$

h. m. s.
$1\ 50\ 56·8 = \tan \frac{t}{2} = 9·7208420$

h. m. s.	
+3 41 53·6	= t
5 10 11·8	R. A.
8 52 5·4	local Sid. time.
9 10 40·9	Chron^r. time.
18 35·5	do. fast.

α Scorpii. E. of Meridian.

	°	′	″		h. m. s.	
Z. D.	77	10	0	at	10 13 36	by Chron^r.
"		0	0	"	14 39	"
"	76	50	0	"	15 39·5	"
Alt.	13	30	0	"	17 32	"
"		40	0	"	18 32	"
"		50	0	"	19 30	"
Mean Z. D.	76	40	0	"	10 16 34·8	"

α Scorpii R. A. 16h 23m 54·3s $\delta - 26° 14′ 4″·7$

	° ′ ″		
obs^d. Z. D. =	76 40 0		
Ref. +	4 1		
	76 44 1		
	46 40 32		
	63 45 55·3		
	187 10 28·3		
	93 35 14·2	cosec	0·0008517
	46 54 42·2	sin	9·8635025
	29 49 18·8	sin	9·6966232
	16 51 13·2	cosec	0·5377093
			20·0984867
h. m. s.	3 12 57·9		= 10·0492434

h. m. s.
−6 25 55·8
16 23 54·3
9 57 58·5
10 16 34·8
18 36·3

h. m. s.
Final mean 18 35·9 fast at 9 25 0 local Sid. time, April 22nd, 1910.

The next and last chance to get star observations was on May 6th, 1910—certainly the best night for star work so far.

Four stars were observed for clock error—as follows:—

α Leporis. W. of Meridian.

	°	′	″		h.	m.	s.	
Z. D.	63	0	0	at	10	24	23	by Chronʳ.
„		10	0	„		25	17	„
„		20	0	„		26	13	„
Alt.	26	20	0	„		28	6	„
„		10	0	„		29	2·5	„
„		0	0	„		29	56	„
Mean Z. D.	63	30	0	„	10	27	9·6	„

α Leporis. R. A. 5h. 28m. 44·6s. δ − 17° 53′ 14″·3

	°	′	″		
obsᵈ. Z. D.	63	30	0	at 10h. 27m. 9·6s.	
Refⁿ.	+	1	56·4		
	63	31	56·4		
90 − φ	46	40	32		
90 − δ	72	6	45·7		
	182	19	14·1		
S =	91	9	37·0	cosec	0·0000891
S − 90 + φ	44	29	5	sin	9·8455439
S − 90 + δ	19	2	51·3	sin	9·5136880
S − Z. D.	27	37	40·6	cosec	0·3337375
				$\tan^2\frac{t}{2}$	19·6930585
	2	20	19·4	$= \tan\frac{t}{2} =$	9·8465292
	+4	40	38·8		
	5	28	44·6		
	10	9	23·4		
	10	27	9·6		
fast		17	46·2		

β Leporis. W. of Meridian.

	°	′	″		h.	m.	s.	
Alt.	26	40	0	at	10	32	16	by Chronʳ.
„		30	0	„		33	9	„
„		20	0	„		34	2·5	„
Z. D.	64	0	0	„		35	51	„
„		10	0	„		36	46·5	„
„		20	0	„		37	41·5	„
Z. D.	63	50	0	„	10	34	57·8	„

β Leporis. R. A. 5h. 24m. 22·3s. δ − 20° 49′ 54″·6

	°	′	″		
obsᵈ. Z. D.	63	50	0	at 10h. 34m. 57·8s.	
Refⁿ.	+	1	58·1		
	63	51	58·1		
	46	40	32		
	69	10	5·4		
	179	42	35·5		
	89	51	17·8	cosec	0·0000014
	43	10	45·8	sin	9·8352369
	20	41	12·4	sin	9·5480932
	25	59	19·7	cosec	0·3583331
					19·7416646
	2	26	24·6	$= \tan\frac{t}{2}$	9·8708323
	+4	52	49·2		
	5	24	22·3		
	10	17	11·5		
	10	34	57·8		
fast		17	46·3		

	m.	s.
	17	46·2
	17	46·3
Mean W.	17	46·2

α Scorpii. E. of Meridian.

	°	′	″		h.	m.	s.	
obsᵈ. Z. D.	72	0	0	at	10	43	31·5	by Chronʳ.
„	71	50	0	„		44	27·5	„
„	71	40	0	„		45	25·0	„
Alt.	18	40	0	„		47	18·5	„
„	18	50	0	„		48	16·0	„
„	19	0	0	„		49	14·0	„
Mean Z. D.	71	30	0	„	10	46	22·1	„

β Scorpii. E. of Meridian.

	°	′	″		h.	m.	s.	
Alt.	19	10	0	at	10	50	52	by Chronʳ.
„	19	20	0	„		51	48	„
„	19	30	0	„		52	44	„
Z. D.	70	10	0	„		54	44	„
„	70	0	0	„		55	36	„
„	69	50	0	„		56	34	„
Mean Z. D.	70	20	0	„	10	53	43	„

α Scorpii. R. A. 16h 23m 54·6s $\delta - 26° 14' 5''\!\cdot\!6$.

	° ′ ″	
obsd. Z. D.	71 30 0	at 10h 46m 22·1s
Refr.	2 52·4	
true Z. D.	71 32 52·4	
$90 - \phi$	46 40 32	
$90 - \delta$	63 45 54·1	
	181 59 18·8	
S =	90 59 39·4	cosec 0·0000654
$S - 90 + \phi$	44 19 7·4	sin 9·8442591
$S - 90 + \delta$	27 13 45·0	sin 9·6604392
$S - z$	19 26 47·0	cosec 0·4776540
		$\tan^2 \frac{1}{2}t$ 19·9824177
	2 57 40·8 = $\tan \frac{t}{2}$	9·9912088
t =	5 55 21·6	
R. A. =	16 23 54·6	
ST.	10 28 33 0	
Clock	10 46 22·1	
Clock fast	17 49 1	

β Scorpii. R. A. 16h 0m 13·5s $\delta - 19° 33' 43''\!\cdot\!3$.

	° ′ ″	
obsd. Z. D.	70 20 0	at 10h 53m 43·0s
	2 41·6	
	70 22 41·6	
	46 40 32	
	70 26 16·7	
	187 29 30·3	
S =	93 44 45·2	cosec 0 0009288
	47 4 13·2	sin 9·8646240
	23 18 28·5	sin 9·5973358
	23 22 3·6	cosec 0·1016145
		19·8645031
	h. m. s. 2 42 11·8 =	9·9322516
	5 24 23·6	
	16 0 13·5	
	10 35 49·9	
	10 53 43·0	
fast	17 53·1	

	h. m. s.
	17 49 1
	17 53 1
Mean E.	17 51 1
„ W.	17 46 2
Clock fast	17 48 6 at 10h 22m 0s May 6, 1910.

By giving only half weight to α and β Scorpii 17 48·6 becomes 17m 47·9s.

Longitude of Camp Peg. Port Davey.

	m. s.	
At Sydney, March 7, 1910, Kullberg 4463 was	8·9	fast with losing rate 2·86 daily.
„ May 20 „ „ „	4 8·94	slow „ „ „ 3·55 „
In 74 days Chronometer lost	4 17·84	
giving average daily losing rate of	3·484	per day. (1)
At Port Davey, May 6, 1910, Chronometer was fast	17 48·6	
„ April 22, „ „ „	18 35·9	
loss in 14 days	47·3	
giving daily losing rate of	3·378	(2)

No. 1 shows that the rate during the absence of the Chronometer from Sydney had become greater than before its departure, and this is confirmed by its rate during the period May 20th to May 31st viz., 3.55s. and also by the observations at Port Davey on

April 22nd, 1910, to May 6th, 1910. Owing to local conditions (Cook's fire and smoke) on May 6th the observations to α and β Scorpii are not as concordant as they might be, and by giving them only half weight then the daily losing rate from April 22nd to May 6th becomes 3.43 s. which is in closer agreement with the average rate from March 7th to May 20th, viz., 3.484 s. daily.

In calculating the longitude of Port Davey it will be assumed that the rate is losing 3.484 s. daily.

	h. m. s.	
On March 7, 1910, at noon Chronometer 4463 was	8·9	fast on Sydney time
by April 22, „ at 8 p.m. (say) „ „ had lost	2 41·4	($46\frac{1}{3} \times 3{\cdot}484$)
on „ „ „ „ „ was	2 32·5	slow on Sydney time
„ „ „ „ „ „ „	18 35·9	fast on Port Davey time
Difference between Port Davey and Sydney =	21 8·4	
Longitude of Sydney =	10 4 49·54	
whence Longitude of Port Davey =	9 43 41·14	(1)

	h. m. s.	
May 20, 1910, Chronometer 4463 was	4 8·94	slow on Sydney time
From May 6 at 8 p.m. to May 20 at noon Chronometer had lost	47·7	($13\frac{2}{3} \times 3{\cdot}484$)
Therefore on May 6, 8 h., Chronometer was	3 21·24	slow on Sydney time
on „ „ „	17 47·9	fast on Port Davey time
Difference between Port Davey and Sydney =	21 9·14	
Sydney Longitude =	10 4 49·54	
Port Davey Longitude	9 43 40·40	(2)

	h. m. s.	
The mean between (1) and (2) is	9 43 40·77	E. of Greenwich.
or in angle =	145° 55′ 11″·6	„
Camp peg East of peg at Siderostat (about)	21·6	(say)
whence Longitude of Siderostat =	145 54 50·0	

Dave Herald used Google Earth to refine the position of the observing site to:
146° 00' 30", -43° 19' 38";
and the camp (as shown in figure 1 to:
146° 00' 17", -43° 19' 52";

CHAPTER VI

DESCRIPTION OF THE CORONA OF 1910

By W. H. Wesley, *Assistant Secretary, R.A.S.*

The photographs from which the drawing has been made were the following:—

1. Four negatives taken by Mr. J. Booton and the Rev. L. S. Macdougall with a Thornton-Pickard $\frac{1}{2}$-plate triple extension camera with back combination of lens removed: diagram Fig. 22. The exposure of one plate is given as 2 secs.; the other plates had apparently similar exposures. Diameter of moon's image 4 mm. 4.

2. Positive copies of a photograph taken by Mr. Sargeant with a small camera of short focus; the details of exposure are not given, but the great deformation of the moon's image caused by the diurnal motion shows that the plate was exposed during the greater part of totality. The diameter of the moon's image in the direction unaffected by the diurnal motion is about 1 mm. 5.

The negatives by Messrs. Booton and Macdougall are very sharply defined, and give excellent pictures, notwithstanding their small scale. But their extension is very small; the corona in no part extends to more than a fourth of the moon's diameter from the limb. Mr. Sargeant's minute photograph, on the other hand, extends in parts considerably more than a diameter, but it shows absolutely no detail except at its outer edges. I have therefore simply drawn it in outline, superposed on a drawing from the other photographs which show the inner corona. On Mr. Sargeant's plate the line of the terrestrial landscape is shown, and this permits the picture to be oriented with approximate correctness. The photograph showing the inner corona agrees so well with the others that there is not much uncertainty about the orientation.

The most striking feature of the corona shown on the small extension plates is an unusually wide rift, arranged pretty symmetrically about the South Pole, and extending for nearly 50° along the limb. Along this rift the corona is almost absent in the short exposure plates—only the faintest indications are given of the bases of the polar rays. In Mr. Sargeant's photograph this rift is entirely filled up to a height of nearly a diameter, probably with the usual polar rays, but the over-exposed small scale picture gives no indication of anything but the general mass.

The great southern rift is bounded on the east by a well-marked mass, such as is frequently seen at the edge of a polar rift. This mass forms the base of a fine ray of a clearly synclinal character, extended in Mr. Sargeant's photograph to nearly $1\frac{1}{2}$ diameters from the limb, in direction not far from radial. A well-marked gap separates this great ray from the general equatorial mass on the east, which presents no very distinctive features.

At the North Pole there is no rift corresponding to that at the South, though the corona has somewhat less extension than in the equatorial regions. The details on the western side are not of a very well-marked character. The edge of the mass bounding the southern rift on the west much more nearly approaches the tangential than the corresponding mass on the east. In the outer corona two or three broad, ill-defined, and somewhat parallel rays run out to more than a diameter from the limb.

Comparing the corona of 1910 with that of 1909 it is evident that the former shows fewer distinctive features. The corona of 1910 appears to belong to the type associated with the period intermediate between the maximum and minimum of solar activity. It much resembles the corona of August, 1896, as photographed by M. Hansky in Novaya Zemlya, but the poles appear *reversed,* the North Pole of 1896 resembling the South Pole of 1910. The long ray on the south-east of the 1910 corona decidedly recalls the similar but still longer streamer photographed by Hansky in 1896.

The most characteristic features in the 1910 corona are the unusually wide rift at the South Pole, without any corresponding rift at the North, and the long ray, with its edges of double curvature, extending from the synclinal group on the east of the great southern rift.

DESCRIPTION OF PLATES

RICHARD CLAY AND SONS, LTD., BREAD STREET HILL, E.C., AND BUNGAY, SUFFOLK.

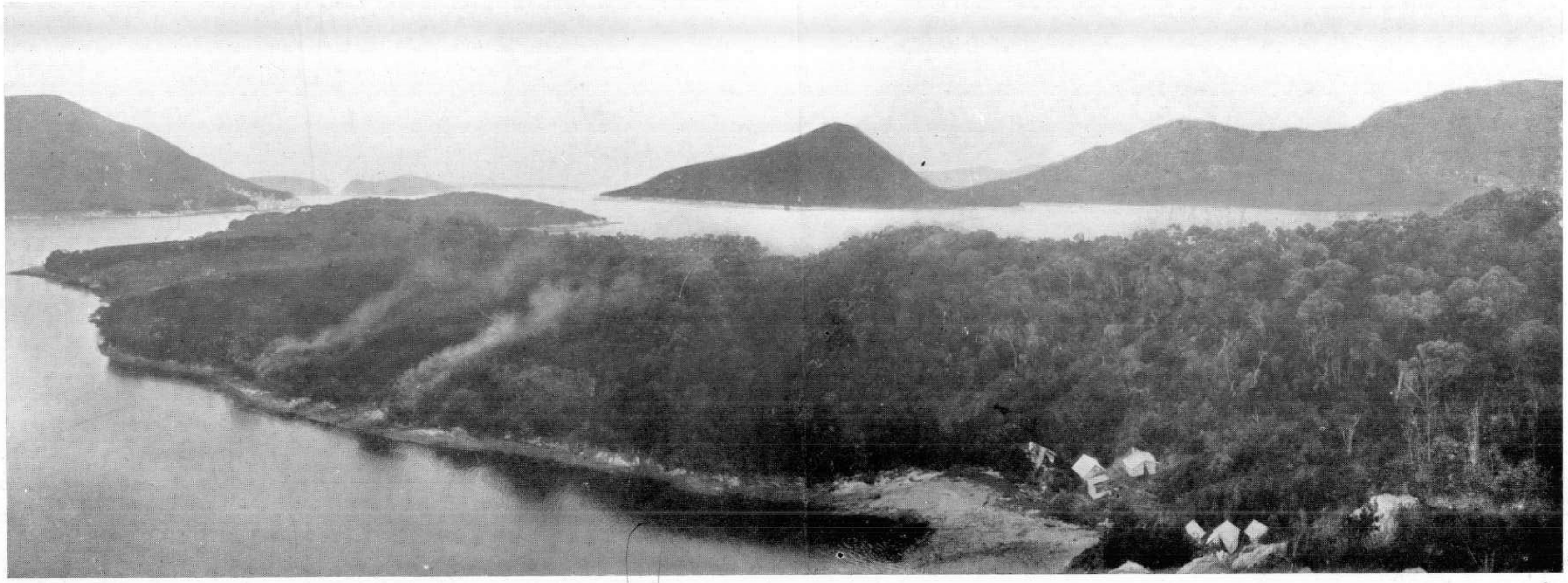
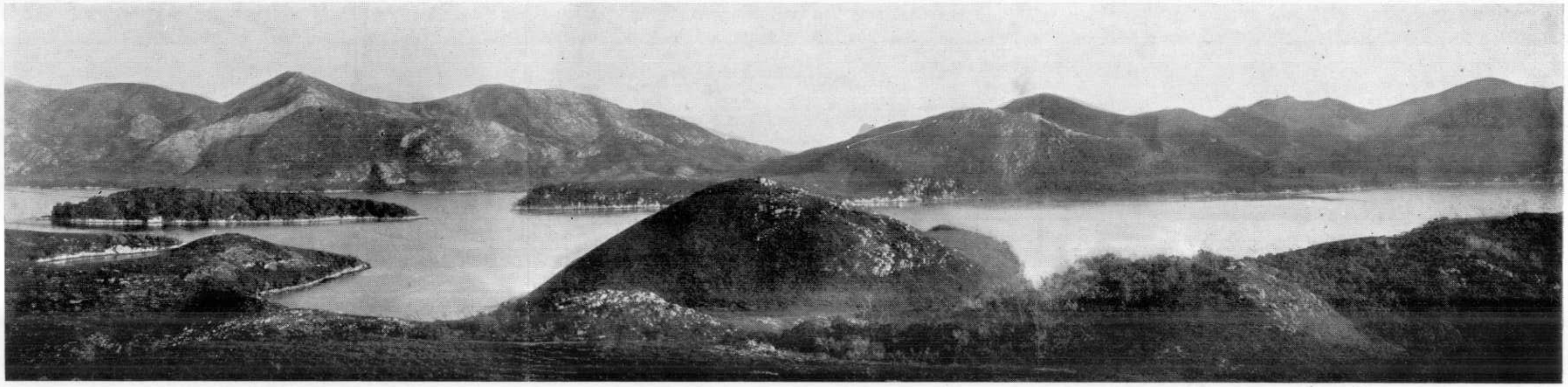


Plate 1



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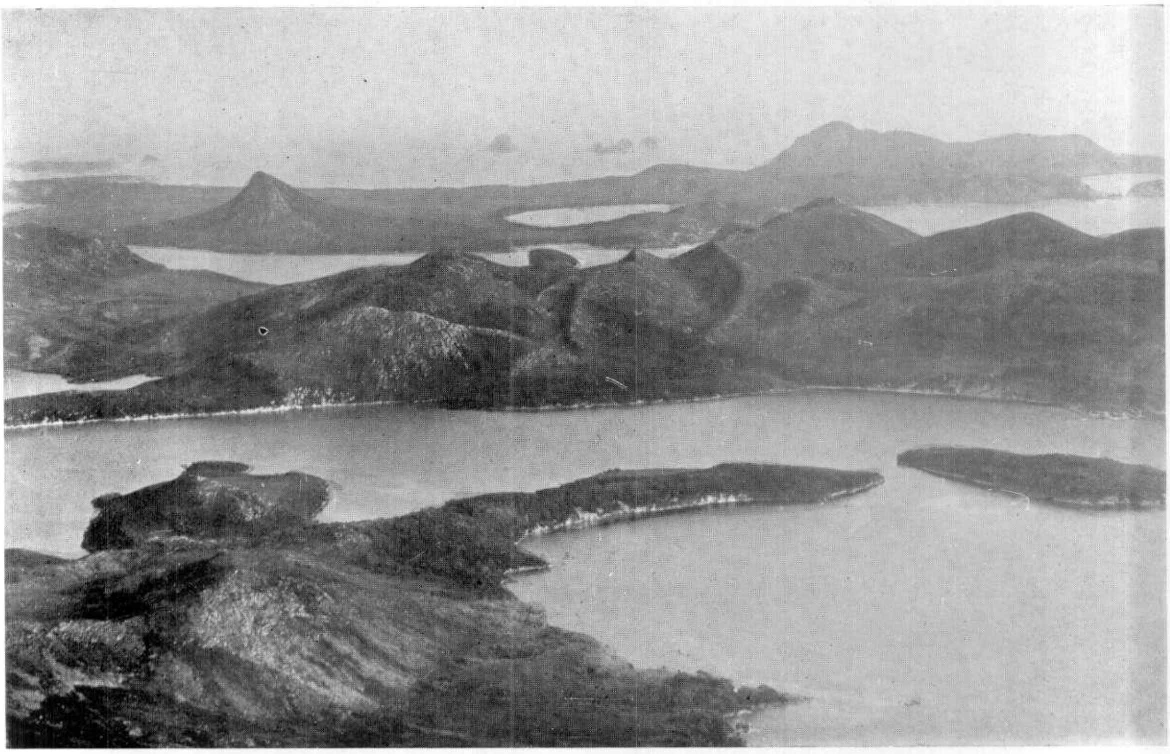

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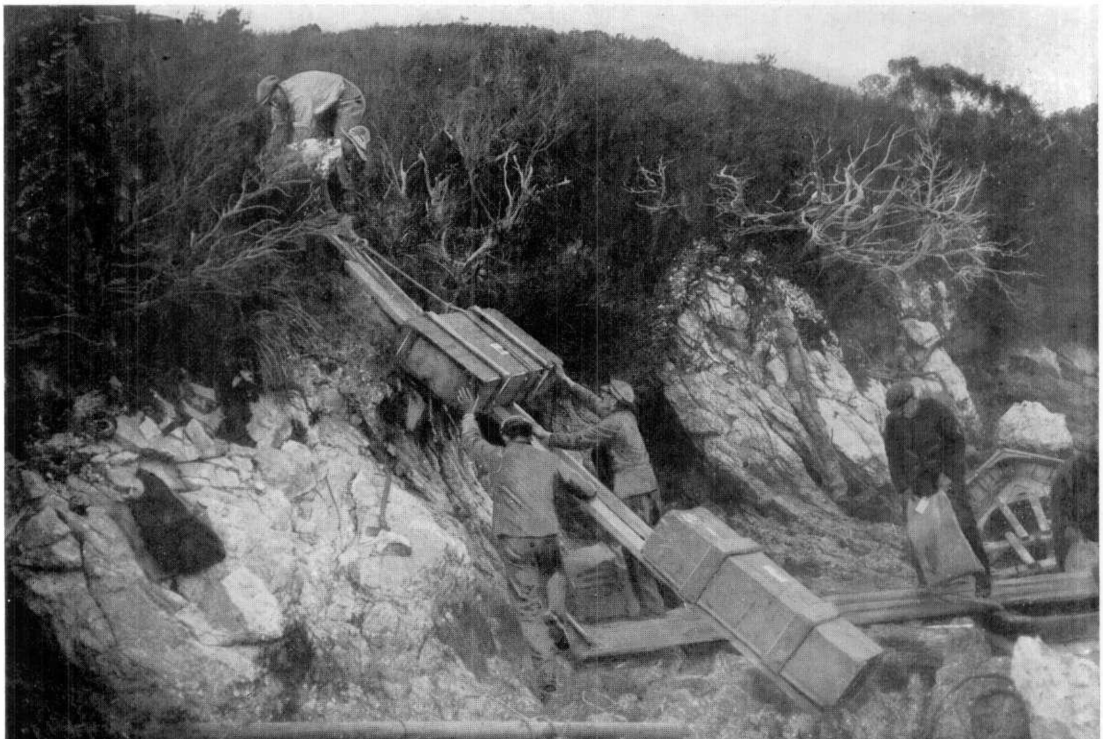

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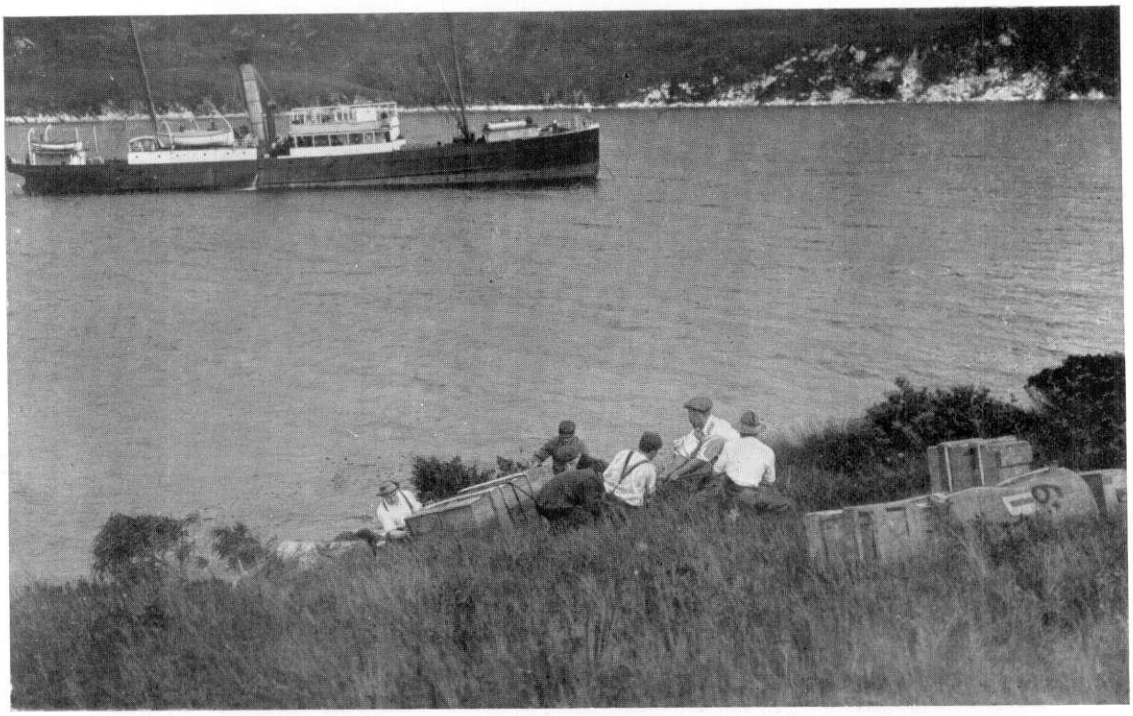


Plate 5

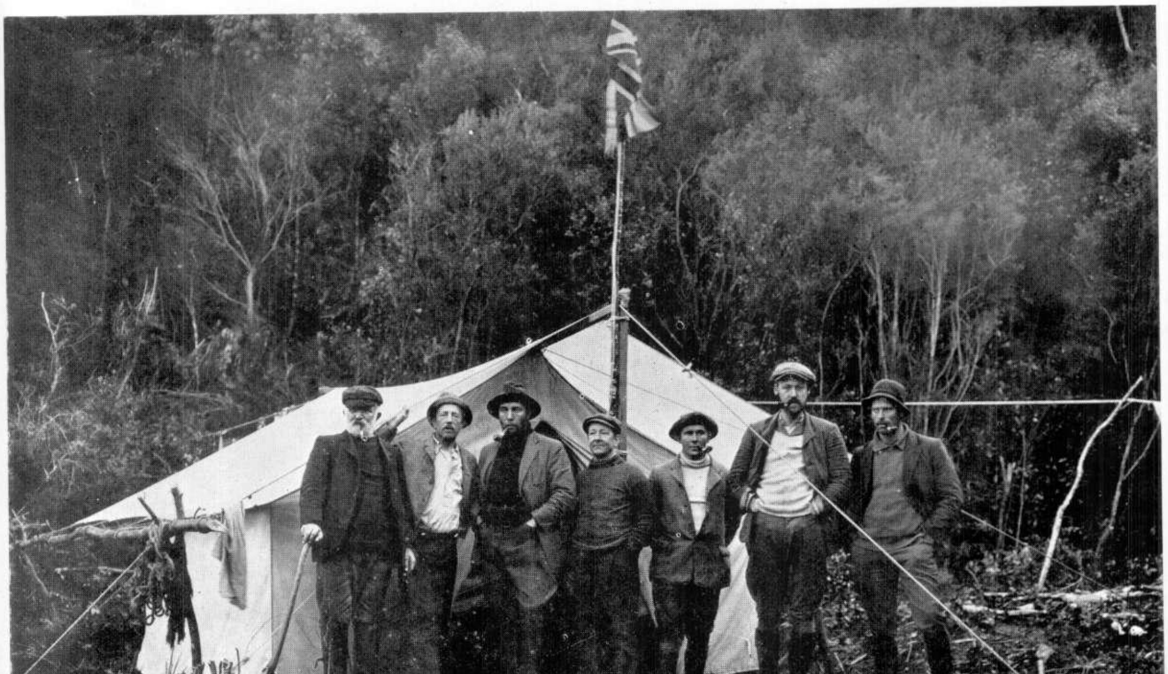


Plate 6

Plate 7

Plate 8

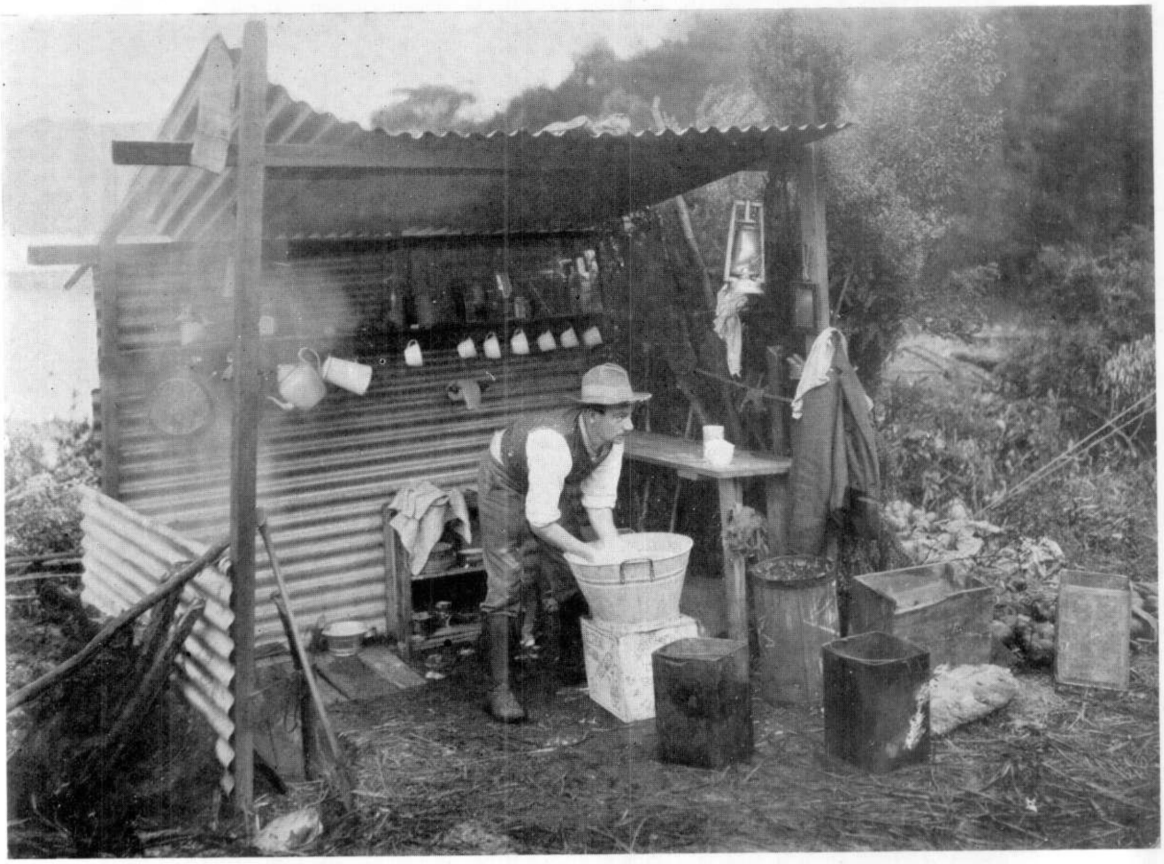


Plate 9

Plate 10

Plate 11

Plate 12

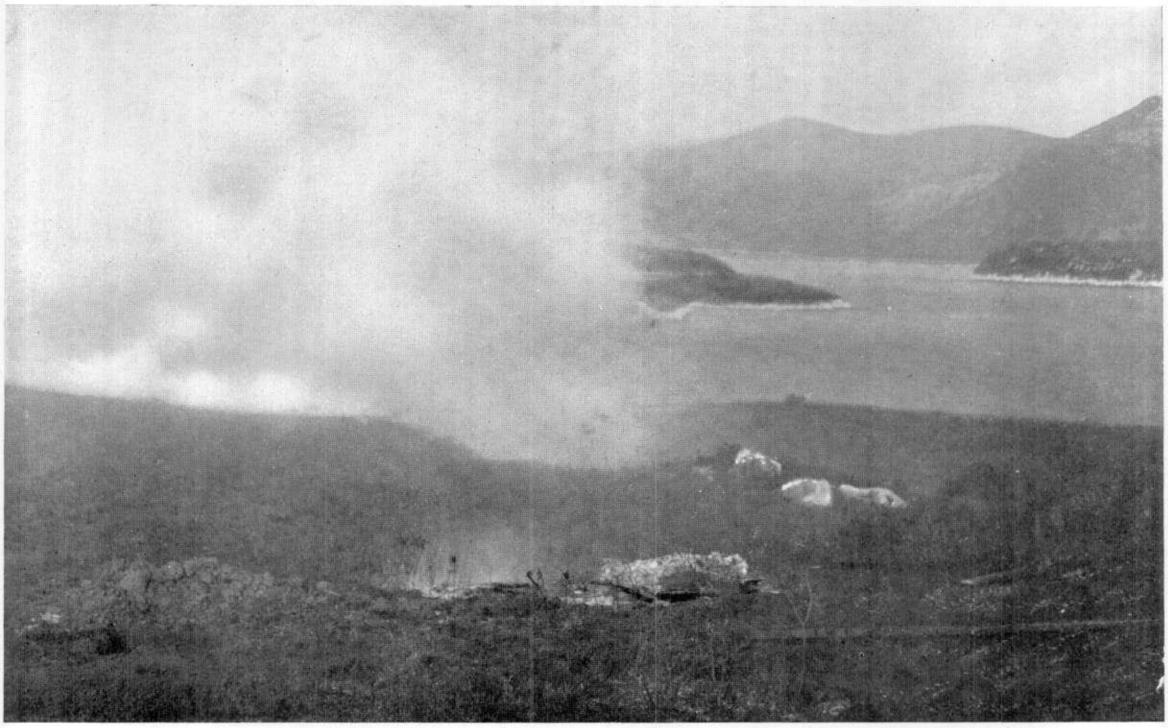


Plate 13

Plate 14

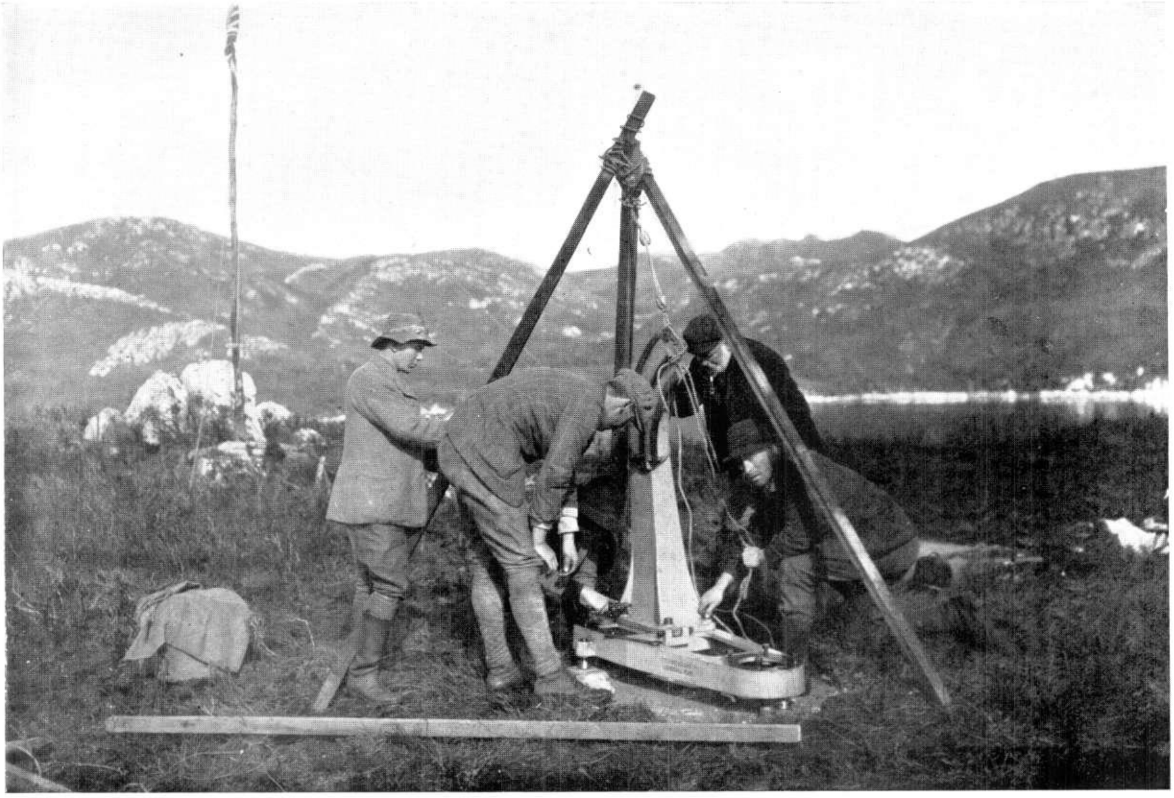


Plate 15

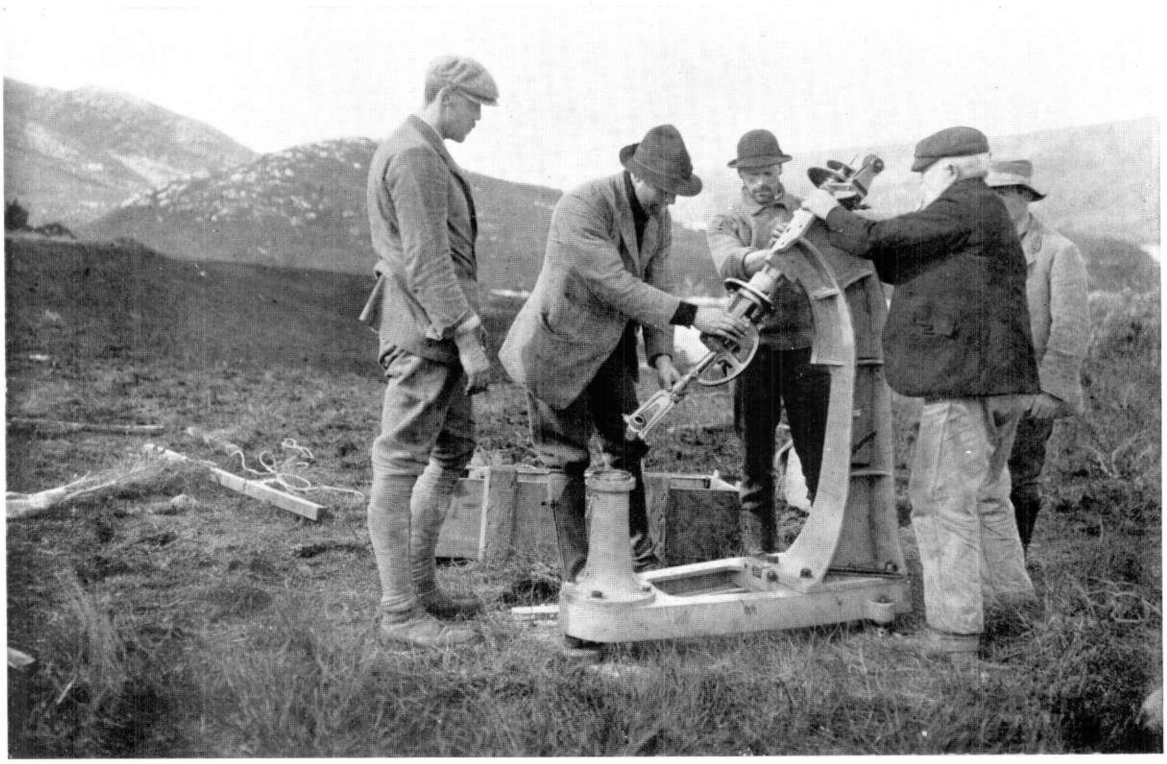


Plate 16

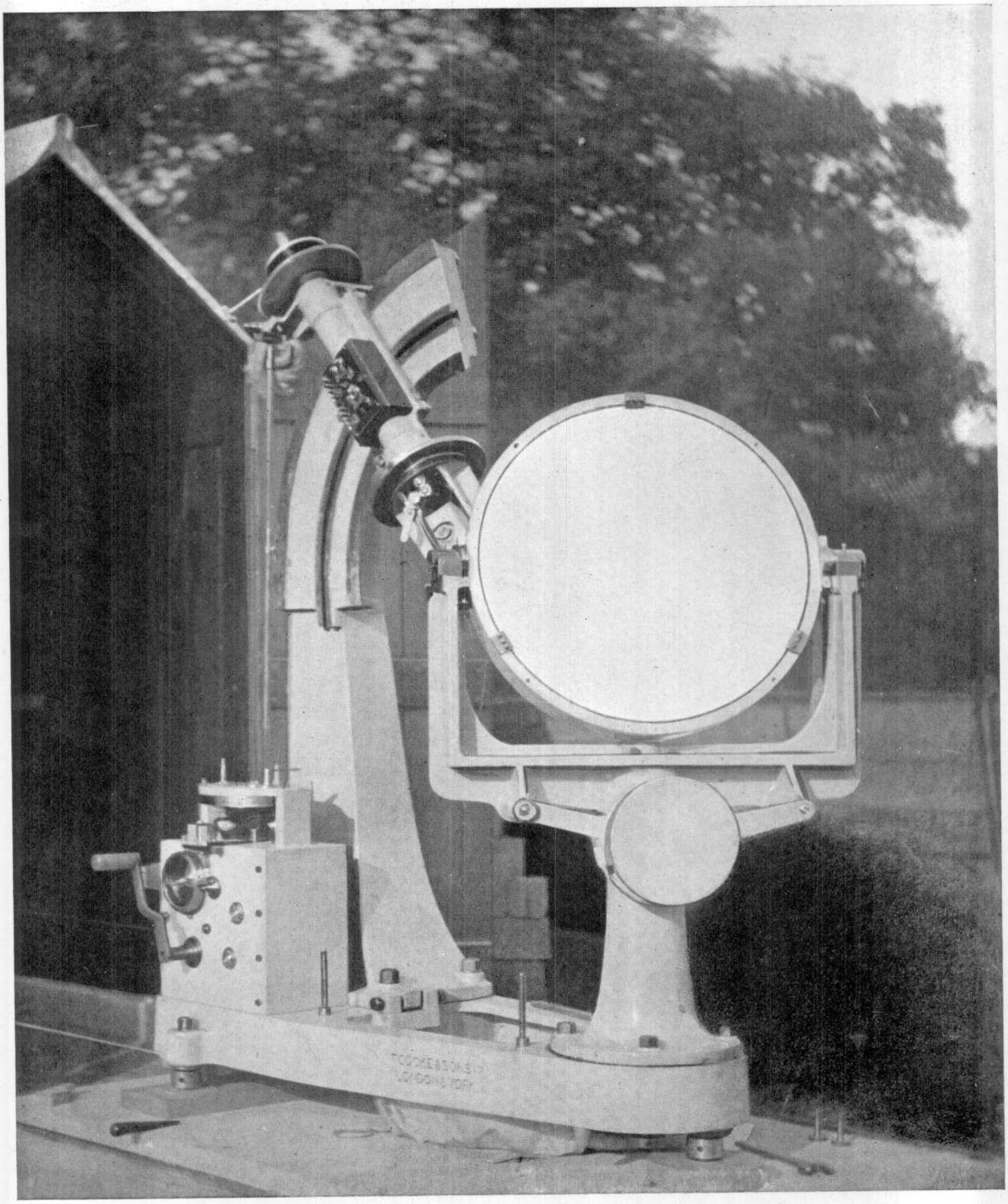
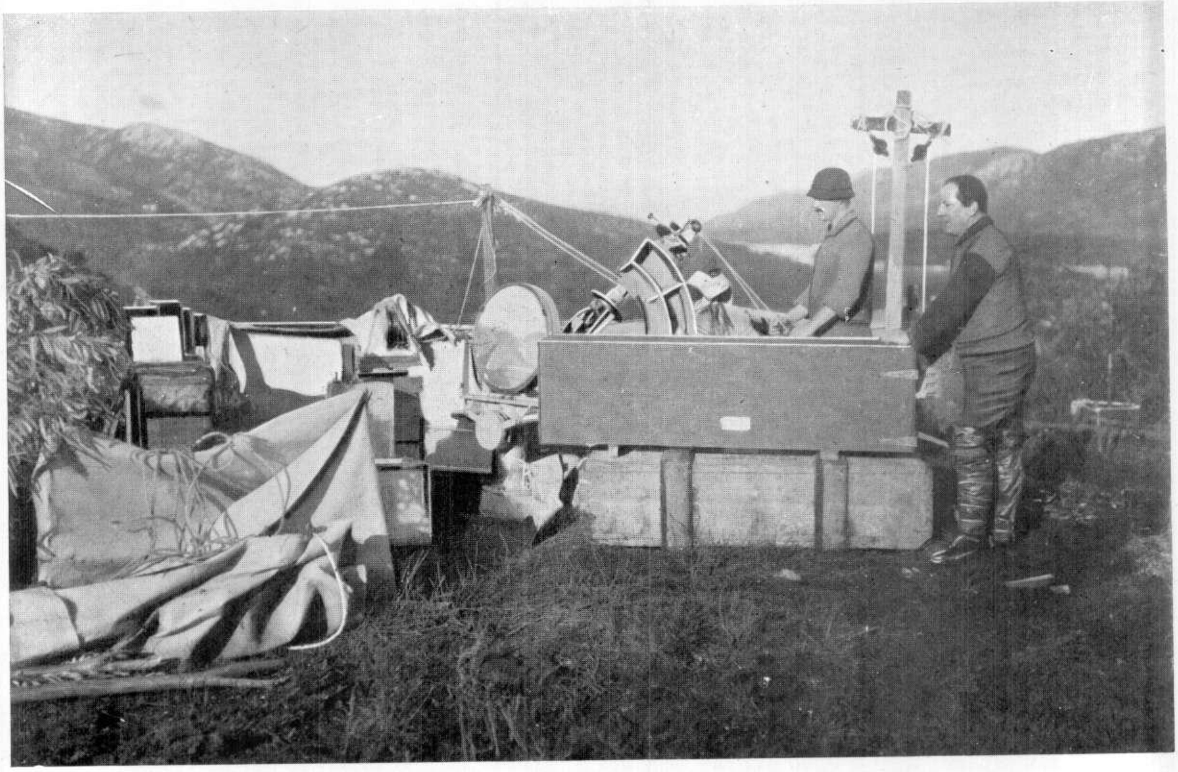


Plate 17

Plate 18

Plate 19



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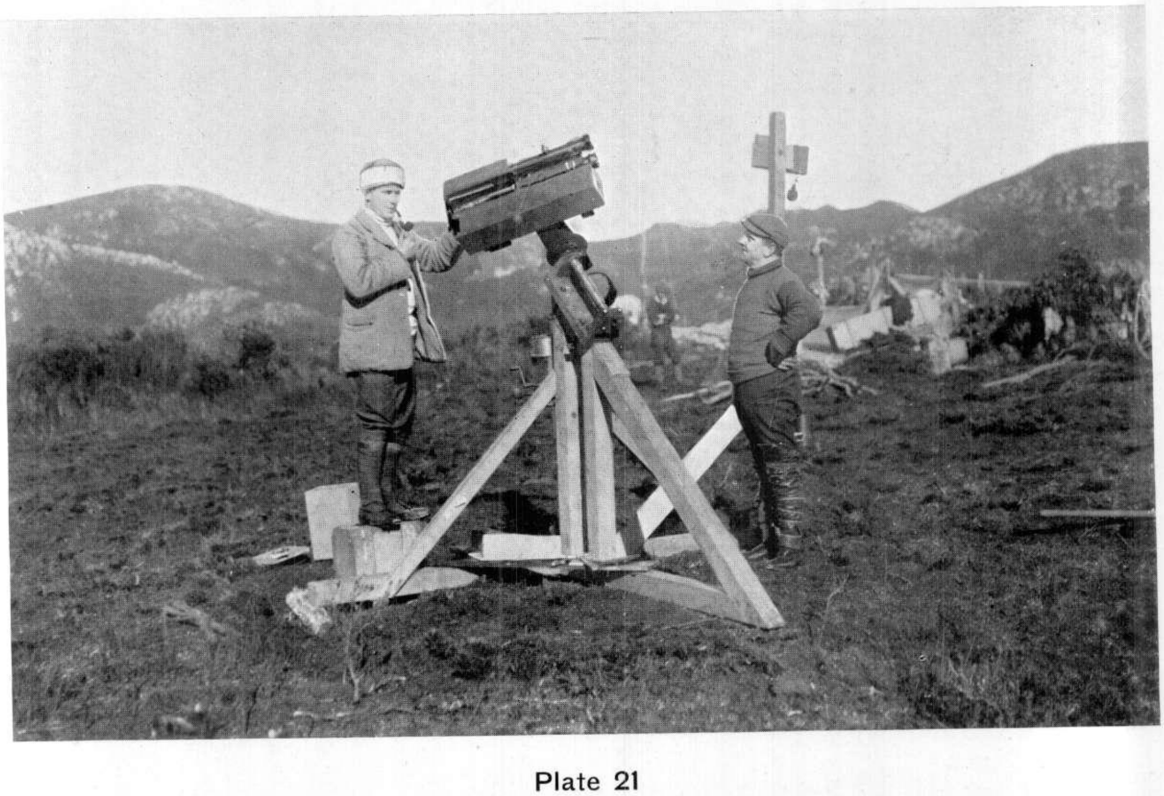


Plate 21

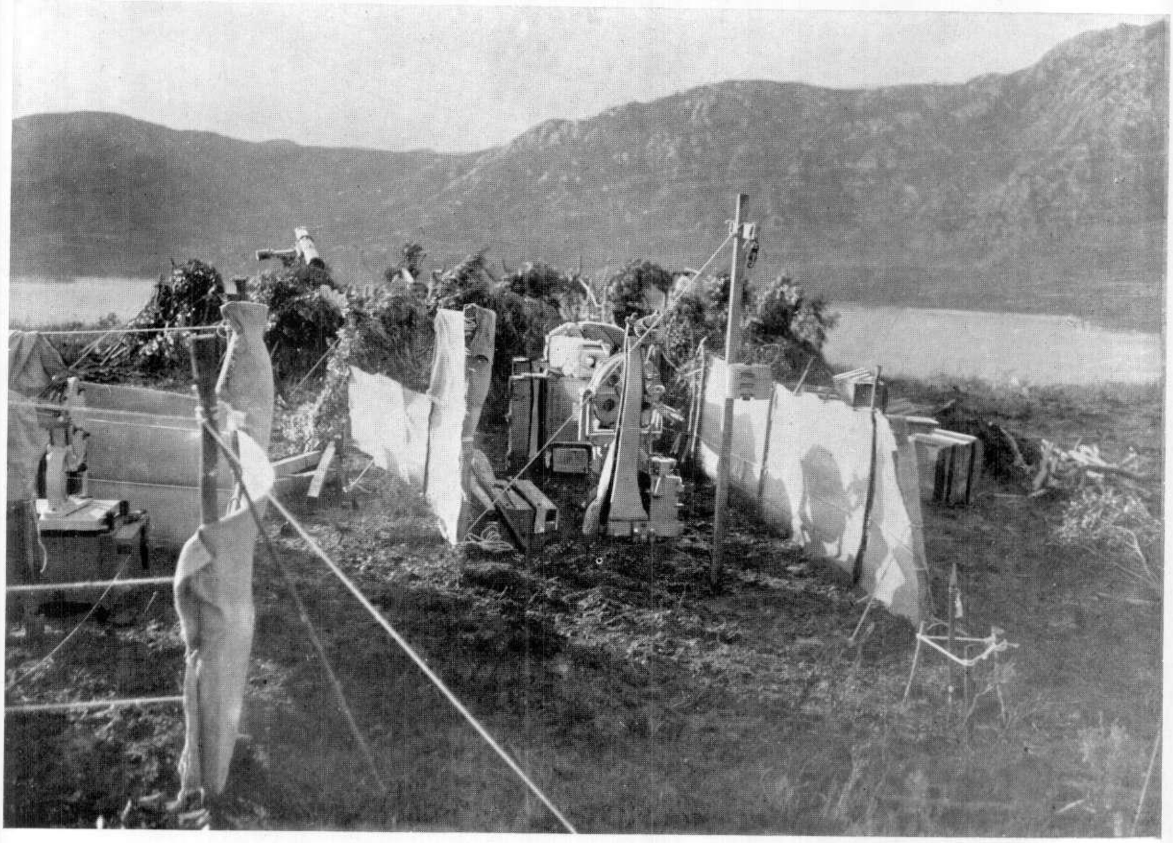


Plate 22

Plate 23

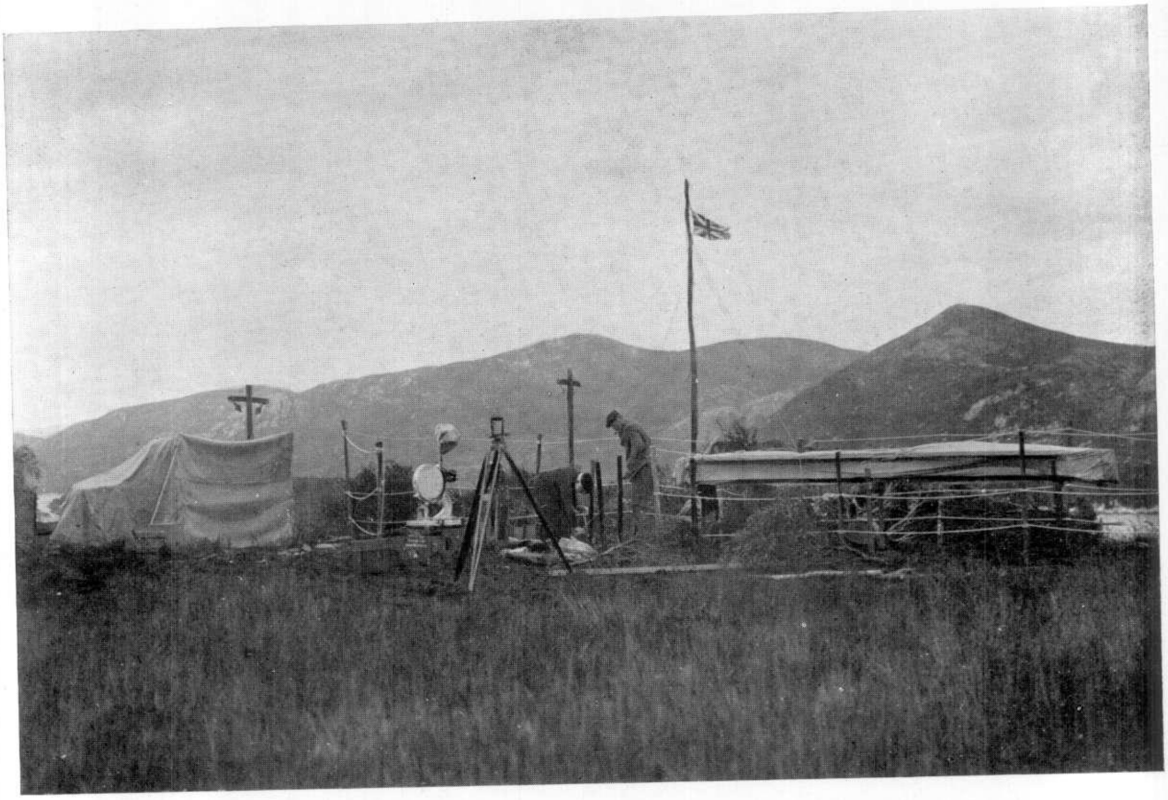
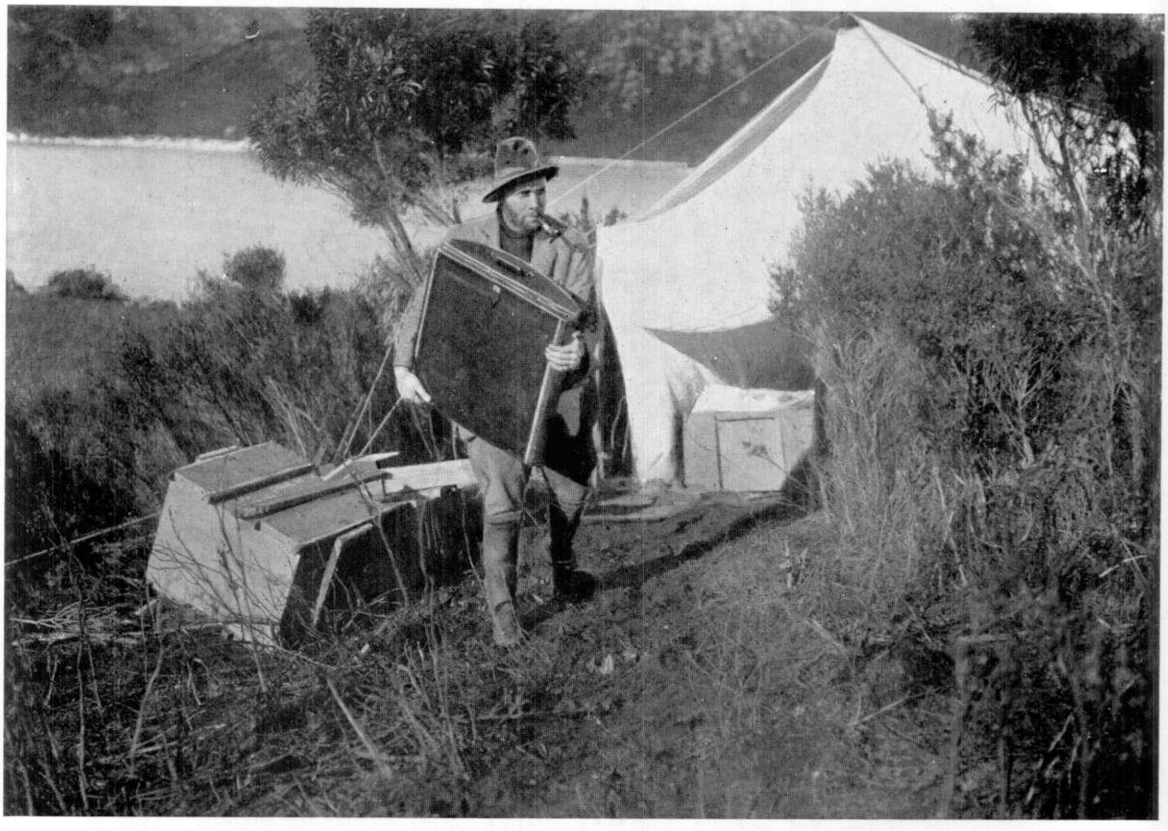


Plate 24

Plate 25

Plate 26



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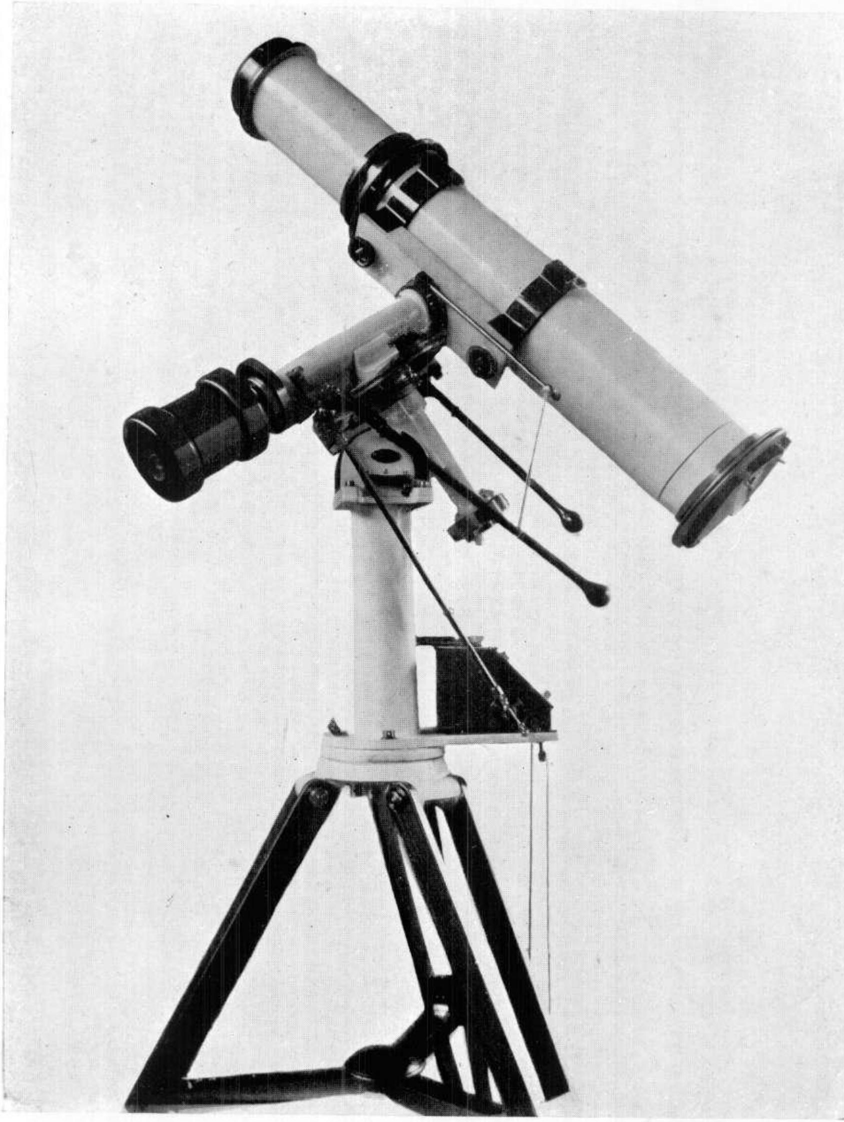

Plate 28

Plate 29

Plate 30

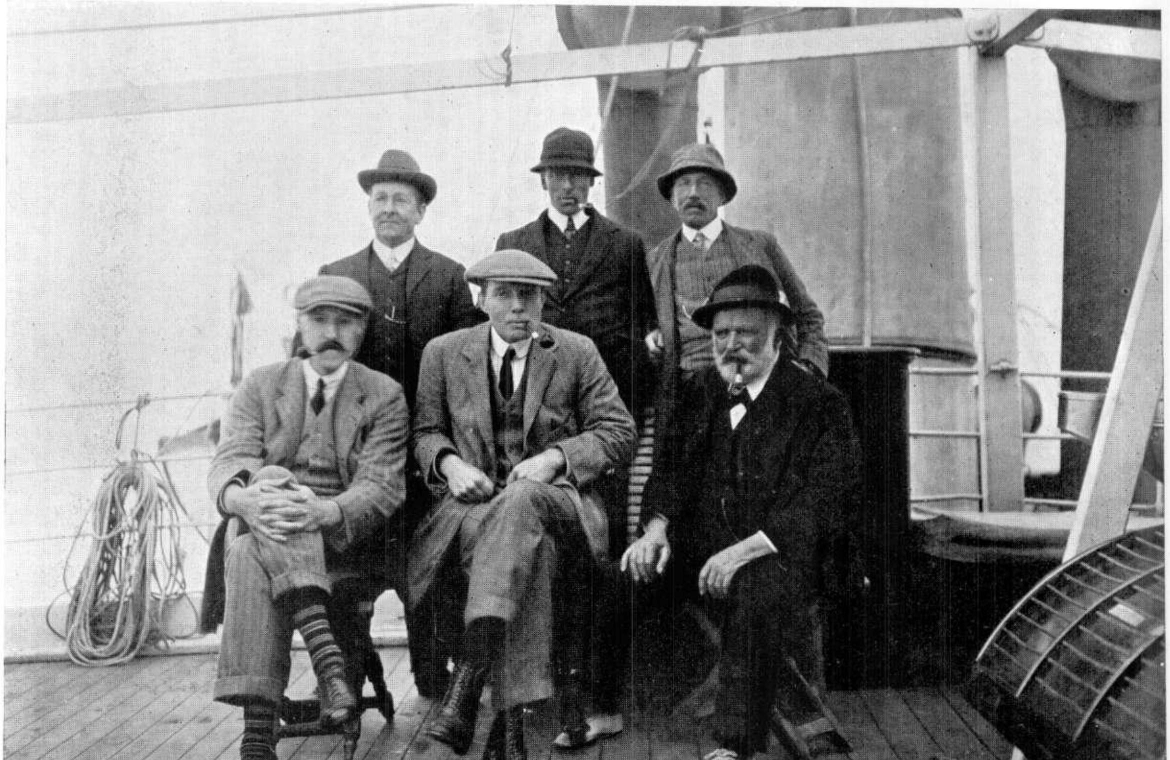

Plate 31

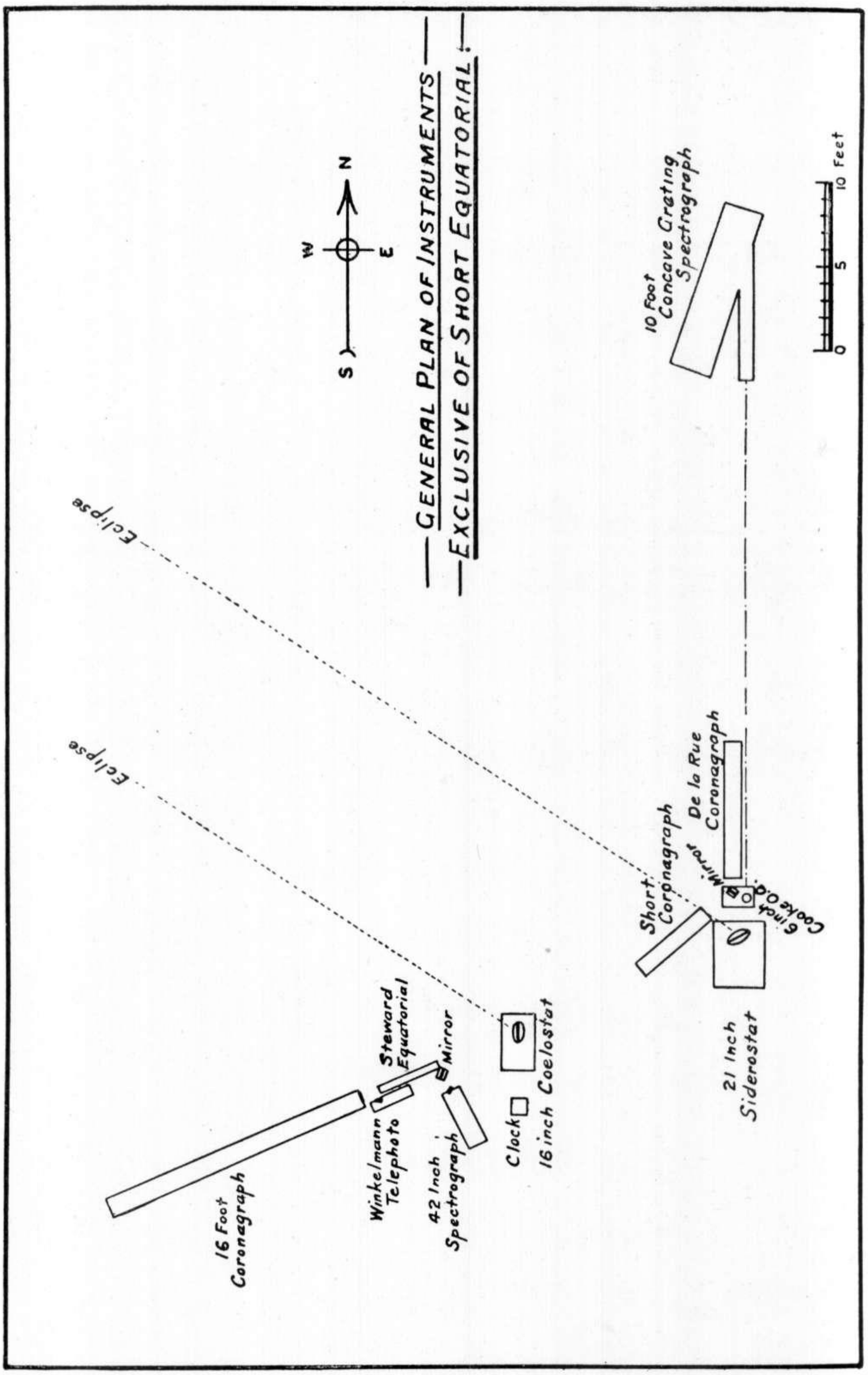
General Plan of Instruments
Exclusive of Short Equatorial
S
N
W
E
Eclipse
Eclipse
10 Foot Concave Grating Spectrograph
0
5
10 Feet
De la Rue Coronagraph
Short Coronagraph
Mirror
6 inch Cooke O.G.
21 Inch Siderostat
16 inch Coelostat
Clock
42 Inch Spectrograph
Steward Equatorial
Mirror
Winkelmann Telephoto
16 Foot Coronagraph

Plate 32

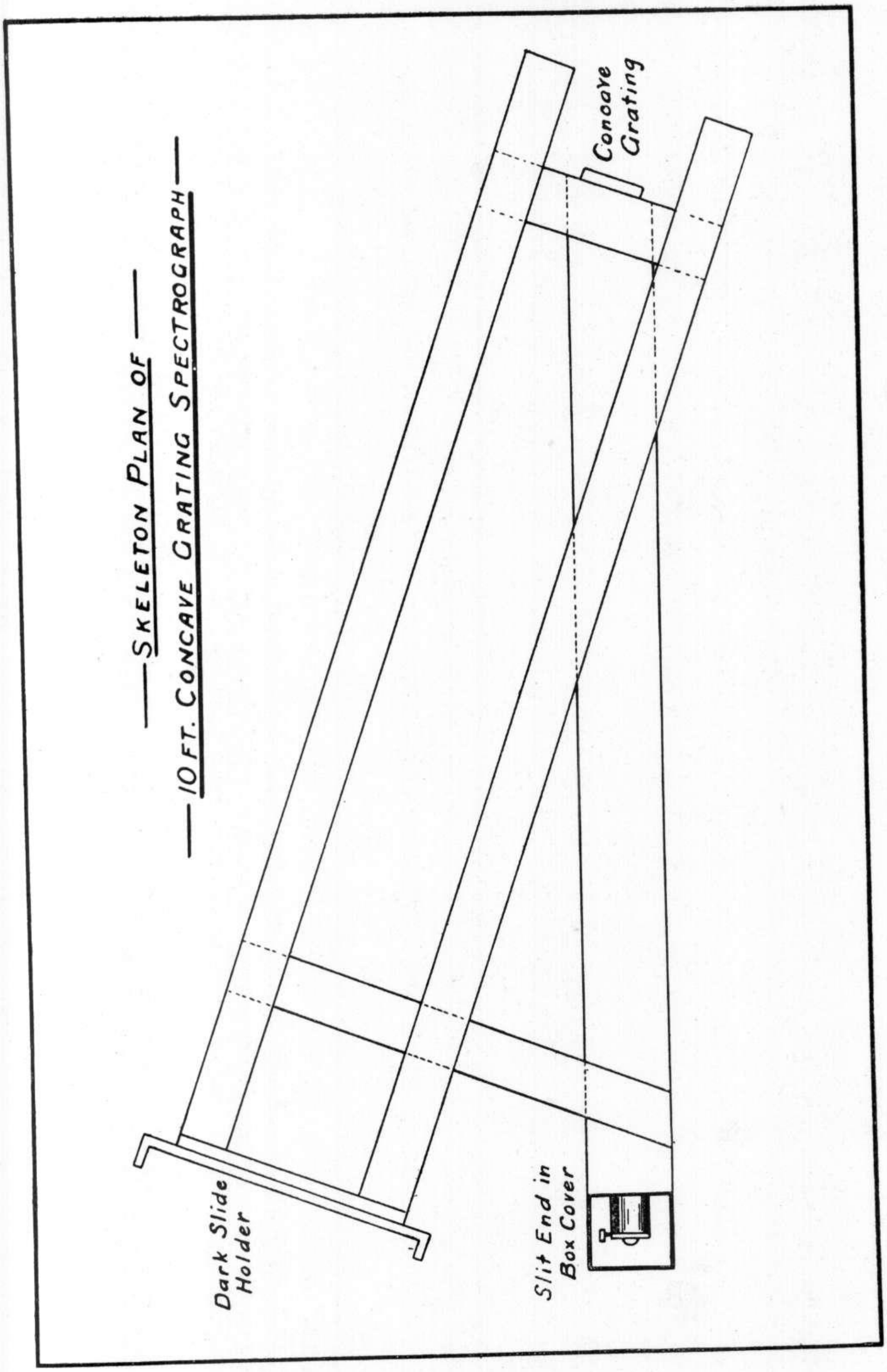
SKELETON PLAN OF
10 FT. CONCAVE GRATING SPECTROGRAPH
Concave Grating
Dark Slide Holder
Slit End in Box Cover

Plate 33

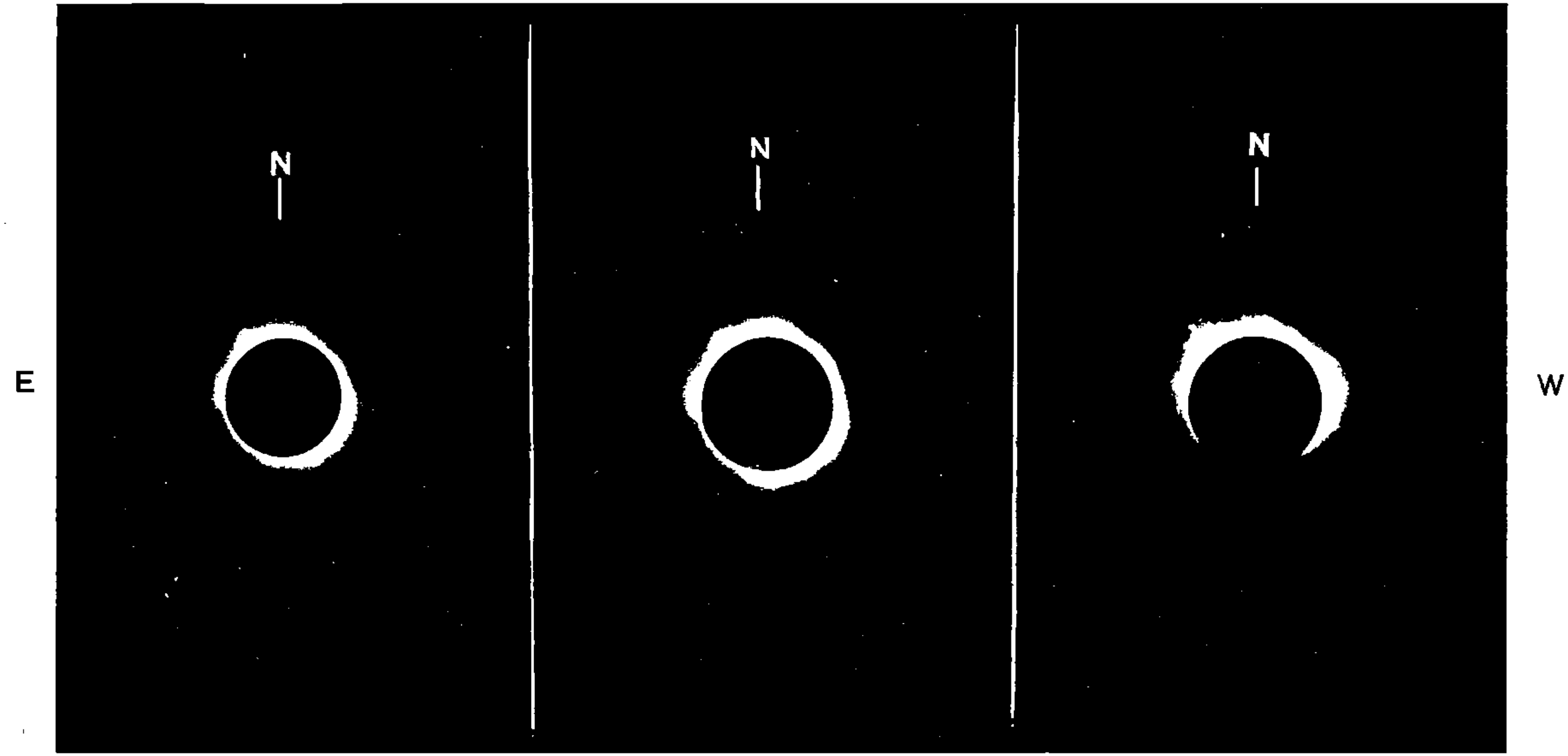

Plate 34

Richard Clay and Sons, Limited,
bread street hill, e.c., and
bungay, suffolk.