

CHAPTER VIII

TRANSITION STUDIES: ART OF TRAVEL, GEOGRAPHY, CLIMATE

A. ART OF TRAVEL

“The highest minds in the highest races seem to have been those who had the longest boyhood.”
FRANCIS GALTON, *Hereditary Talent and Character*, Aug. 1865.

“I have been speculating last night what makes a man a discoverer of undiscovered things; and a most perplexing problem it is. Many men who are very clever—much cleverer than the discoverers—never originate anything. As far as I can conjecture the art consists in habitually searching for the causes and meaning of everything which occurs. This implies sharp observation and requires as much knowledge as possible of the subject investigated. But why I write all this now I hardly know, except out of the fulness of my heart.”

CHARLES DARWIN, Letter to his son Horace, Dec. 15, 1871.

WE left Francis Galton at the end of our first volume aged 32, married, with many social friends, an ample competence, and a mind trained both in observation and analysis. His experience had been such that he knew more of mathematics and physics than nine biologists out of ten, more of biology than nineteen mathematicians out of twenty, and more of pathology and physiology than forty-nine out of fifty of the biologists and mathematicians of his day. Added to these advantages he had gained a knowledge of man and his habits in various lands; this gave him additional width of view, if it rendered less obvious to him that field of investigation wherein his powers were ultimately to achieve their most noteworthy successes. Indeed, had Galton been asked in 1854 what was his calling and the nature of his studies, there is little doubt that he would have replied: “I am a traveller by inclination and my study is geography.” In his *Memories*¹ Galton tells us that he was

“rather unsettled during a few years, wishing to undertake a fresh bit of geographical exploration, or even to establish myself in some colony; but I mistrusted my powers, for the health that had been much tried had not wholly recovered.”

Whether marriage or health was the real source of Galton's ‘Wanderlust’ being reduced to vacation rambles, it would be hard to say, but we have probably to thank one or the other for his continued presence in England at a time when startling new ideas were to strike upon his receptive mind. Immediately, however, travel, geography, and closely associated therewith, climate, were to occupy his attention; and he did not touch these things without leaving his mark upon them.

“It was not long after my marriage,” he writes, “that the character of a piece of work that lay before me was clearly perceived. It was ready to be taken in hand and most suitable to my

¹ pp. 161-2.

powers. It was to aid others in the exploration of the then unknown parts of the world, especially of Africa, of whose total length as much had been seen by me in my two journeys as perhaps by anyone else then living. Being placed on the Council of the Royal Geographical Society¹, I thoroughly utilised that position to fulfil my object."

Galton in the first place set about making travel an art to be learnt, and in the next place he determined to make the traveller a real contributor to geographical discovery.

Those who have watched the development of geography as an academic training in recent years must be struck by the manner in which Galton foresaw its expansion and must, perhaps, occasionally wonder whether its instructors might not still learn something from Galton's early geographical writings. In much the same way Galton's *Art of Travel* first published in 1855—and in the fifth edition of 1872, reaching the most catholic comprehensiveness compatible with pocket dimensions—remains still a treasury not only for the professed traveller, but for the leaders of boy-scouts and girl-guides; nay, there are methods to be learnt in the *Art of Travel* which may bring profit to the ordinary household of to-day². Even what appears on the surface especially intended for the explorer may be found on careful reading to have a home-stayer's application. Thus:

"Travellers are apt to expect too much from their medicines, and to think that savages will hail them as demigods wherever they go. But their patients are generally cripples who want to be made whole in a moment, and other suchlike impracticable cases. Powerful emetics, purgatives and eye washes are the most popular physickings.

The traveller who is sick, away from help, may console himself with the proverb, that 'though there is a great difference between a good physician and a bad one, there is very little between a good one and none at all'." (5th Edn. p. 14.)

or again:

"*Shirt-sleeves*—When you have occasion to tuck up your shirt-sleeves, recollect that the way of doing so is, not to begin by turning the cuffs inside out, but outside in—the sleeves must be rolled up inwards towards the arm, and not the reverse way. In the one case, the sleeves will remain tucked up for hours without being touched; in the other, they become loose every five minutes." (*Ibid.* p. 116.)

It is difficult to give a résumé of the *Art of Travel*. By the fifth edition Galton seems to have thought of most things that any type of traveller would require in any possible climate or country. From outfit and servants to medicine, fire, tents, fuel, food, treatment of animals, signalling, surveying,

¹ Royal Geographical Society: Honorary General Secretary 1857–63, Foreign Secretary 1865–66, Member of the Council either by election or *ex officio* almost continuously from 1854 to 1893, Vice-President 1866–72, 1879–86, 1888–91.

² How simple and obvious some of these suggestions are and yet how much might still be learnt from them! Powders for medicinal use should be mixed with coloured flours to distinguish emetics from aperients or to emphasise poisons; where ammonia and the 'blue bag' are not available—on a walk or at a picnic party—oil of nicotine scraped from a pipe, generally at hand, will relieve the pain of a wasp or bee sting. Or, again, such simple directions as those concerning blistered feet where beyond the usual soaping of the insides of the stockings before a long walk, we read "after some hours on the road, when the feet are beginning to be chafed, take off the shoes and change the stockings; putting what was the right stocking on the left foot, and the left stocking on the right foot";—and when a blister is formed pour a little brandy or other spirit into the palm of the hand and drop tallow from a lighted candle into it, rub the feet with this mixture on going to rest, and "on the following morning no blister will exist."



Francis Galton, from a photograph taken after his return from Damaraland, *circa* 1855.

finding the path, etc., even to the conclusion of the journey and the printing of the maps, it is all there, tersely given, with just the needful diagrams and sketches. Many are the mechanical 'dodges,' here given; of such Galton never wearied. He had watched craftsmen in all the lands through which he had travelled and he never tired of experimenting and of model-making¹. And much of this he has used in his *Art of Travel*. The reader of his South African book will recognise also the individual experiences which gave rise to several of the hints in the present work.

If a few formulae or a small amount of measurement can be thrown in, Galton will gladly provide them. The following is a good illustration:

"THE RUSH OF AN ENRAGED ANIMAL is far more easily avoided than is usually supposed. The way the Spanish bull-fighters play with the bull, is well known; any man can avoid a mere headlong charge. Even the speed of a racer which is undeniably greater than that of any wild quadruped, does not exceed 30 miles an hour, or four times the speed of a man. The speed of an ordinary horse is not more than 24 miles an hour; now even the fastest wild beast is unable to catch an ordinary horse, except by crawling unobserved to his side, and springing upon him; therefore I am convinced that the rush of no wild beast exceeds 24 miles an hour, or three times the speed of a man...It is perfectly easy for a person who is cool, to avoid an animal by dodging to one side or another of a bush. Few animals turn, if the rush be unsuccessful. The buffalo is an exception; he regularly hunts a man, and is therefore peculiarly dangerous. Unthinking persons talk of the fearful rapidity of a lion's or tiger's spring. It is not rapid at all; it is a slow movement, as must be evident from the following consideration. No wild animal can leap ten yards, and they all make a high trajectory in their leaps. Now think of the speed of a ball thrown or rather pitched, with just sufficient force to be caught by a person ten yards off; it is a mere nothing. The catcher can play with it as he likes; he has even time to turn after it, if thrown wide. But the speed of a springing animal is undeniably the same as that of a ball, thrown so as to make a flight of equal length and height in the air. The corollary to all this is that if charged, you must keep cool and watchful, and your chance of escape is far greater than non-sportsmen would imagine." (4th Edn. p. 251.)

While traces of the personality of Galton will be found by those who knew him well on almost every page of the *Art of Travel*, there are passages which mark unconsciously his views and the course of his development from 1853 to 1867. There are omissions also in later editions which tell exactly the stage he had reached.

From Damaraland and Ovampo few if any animals, birds or insects were brought back. Galton then and in the *Art of Travel* considered them from the standpoint of sport and food. His list of instruments contains no microscope or dissecting tools, and of books no work on natural history. The sole reference to the collection of specimens occurs in the last paragraph where a description is given of how to make a specimen box from a flat card (3rd Edition, 1860). There is not a word as to how to observe and record the anthropometric characters, folk-lore or religious customs of savage man; neither callipers, tape, nor colour standards appear in Galton's instrumentarium.

¹ The Galton Laboratory possesses a whole series of rough models in card, wood or glass; 'Galton's Toys,' as we call them. Of the purpose of many we know absolutely nothing; others were initial attempts at Galton's hyperscope, heliostat, etc. Besides these 'Toys' are quite a number of instruments chiefly optical made by practical instrument makers to Galton's plans, but in certain cases it has so far been impossible to determine for what purposes they were intended.

These are very noteworthy omissions in a man who was among the foremost anthropologists in this country later to study both the psychic and physical characters in man. In the *Art of Travel* Galton had essentially the needs of the geographer—in the narrower sense—in view; the physical country is more important than its inhabitants. It is possible that this is a general rule in life; in youth it is the novelty of the physical environment, but at a later age it is the novelty of new organic types that forms the intense pleasure of travel¹.

Even as late as 1878 when Galton edited the fourth edition of *Hints to Travellers*, a useful compendium for travellers issued by the Royal Geographical Society, while we find a section on the "Collection of Objects of Natural History" there is no reference to man, and the sole approach to any "Hint" of an anthropological nature in the work is a brief note of 17 lines on p. 71 by the Rev. F. W. Holland describing how paper squeezes may be taken of inscriptions. Even the article on photography does not refer to the photography of the natives, or their habitations and occupations. The book is excellent as a guide to the instruments and processes needful to the map-maker; it lacks all that would give the local human colour to the environmental description. We are not criticising the book from the standpoint of modern academic geography, which does consider man in relation to the physical environment it depicts. We are merely emphasising that Galton in the period we are discussing had not yet discovered his real *métier*—anthropology in its broadest sense. He was doing yeoman service for geography, but the study of man's development, its knowable past and probable future, had not yet fascinated him, still less did it dominate his activities.

The *Art of Travel* shows us indirectly also how undeveloped Galton's mind was in another direction even in 1860. In the third edition of this book we read:

"The method of obtaining fire by rubbing sticks together was at one time nearly universal. It seems remarkable that the time of discovery of the art of fire-making is not recorded in the Bible. We may easily imagine that our first parents obtained their fires from natural sources; of which, some parts of the Caucasus at least, abound in examples. But when Cain was sent an outcast, how did *he* obtain fire? It is remarkable that his descendants are precisely those who invented metallurgy, and arts requiring fire. We might almost theorise to the effect that he or they discovered the art of fire-making, and pushed the discovery into its applications." (p. 27.)

Then follows the well-known passage from Pliny's *Natural History* on the best wood for fire-sticks. In the fourth edition of the *Art of Travel* of 1867 this passage as to our "first parents" and as to Cain as the inventor of fire-sticks has disappeared. Between 1860 and 1867 Galton had read and assimilated Darwin's *Origin of Species*, and in Galton's own words that book had formed "a real crisis in my life" and had driven away "the con-

¹ The rule is of course not invariable. The present writer spent much time in the Austrian Tyrol in his youth, and was on one occasion asked to write a handbook to the Tyrol as one of a series of guidebooks to the Alps. Nothing came of the proposal, because he replied that it must in the first place be a guide to the folk-lore, history, art and institutions of the Tyrolese themselves, and in the second place only a route book to valleys, passes and peaks.

straint of my old superstition as if it had been a nightmare, and was the first to give me freedom of thought." (See Galton's letter to Darwin, Plate II of Vol. I.)

In the rapid growth of our knowledge of the wonderful process of human development, extending now over nearly a quarter of a million years, and with our present certainty that man has used fire for a great portion of that period, the suggestion that the discovery of how to make fire was a product of those last few thousand years which biblical folk-lore endeavours to cover, may well raise a smile. But does the modern reader realise when he smiles at and criticises the mid-Victorians that it was they—Darwin, Galton, Huxley, Clifford and others—who worked their way from such ignorance to insight and gave him the power to smile at it¹?

To turn to a lighter matter before we leave the *Art of Travel* for good, we may find, even in such a work cram full of detail and technique, sure traces of Galton's sense of humour. Thus, having remarked that asses to kick must put their head to the ground and to bray must raise their tail, and described how the head can be kept up and the tail kept down, he remarks:

"In hostile neighbourhoods, where silence and concealment are sought, it might be well to adopt this rather absurd treatment [lashing the tail to a heavy stone]. An ass who was being schooled according to the method of this and the preceding paragraph, both at the same time, would be worthy of an artist's sketch." (4th Edn. p. 61.)

Again, talking of *Duck-Shooting*, Galton remarks:

"It is convenient to sink a large barrel into the flat marsh or mud, as a dry place to stand or sit in, when waiting for the birds to come. A lady suggests to me, that if the sportsman took a bottle of hot water to put under his feet, it would be a great comfort to him, and in this I quite agree; I would take a keg of hot water, when about it." (*Ibid.* p. 253.)

Talking about *Natives' Wives* as members of a party, Galton commends them as giving great life to a party and as being invaluable in picking up gossip, which will give clues of importance, otherwise often missed. He considers in a special paragraph the *Strength of Women*, which he finds adequate for the march, and adds:

"It is the nature of women to be fond of carrying weights; you may see them in omnibusses (!) and carriages, always preferring to hold their baskets or their babies on their knees, to setting them down on the seats by their sides. A woman, whose modern dress includes, I know not how many cubic feet of space, has hardly ever pockets of a sufficient size to carry small articles, for she prefers to load her hands with a bag or other weighty object." (*Ibid.* p. 8.)

Lastly while Galton admitted that men without independent means could turn travel to excellent account as in opening up new countries, finding natural history specimens or hunting for ivory, there is no doubt that he

¹ Nay, does he realise how widespread is still the ignorance of human history in the apparently 'educated' classes? During the few months that the cases containing objects bearing on man's development have been on view in the little museum of the Galton Laboratory we have received more than one remonstrance against the dating of a neolithic skeleton at 8000 years and of palaeolithic man at over 50,000 years, as incompatible with the 'well-known date' of the creation of the world!

thought, as most will hold too, that the ideal traveller was a man like himself:

“If you have health, a great craving for adventure, at least a moderate fortune, and can set your heart on a definite object, which old travellers do not think impracticable, then—travel by all means. If, in addition, you have scientific taste and knowledge, I believe that no career, in time of peace, can offer to you more advantages than that of a traveller.” (4th Edn. p. 1.)

Such then is the *Art of Travel* planned as Galton himself states during his South African exploration of 1850–51. It deserves a new edition, brought up in substance and illustration to date—if the all-round knowledge, such as Galton had, still has its representative¹.

We cannot, however, leave the subject of travel without referring to two or three other enterprises in which Galton had a hand. Notable among these is the *Vacation Tourists and Notes of Travel*, of which he was the originator and editor. It was to be an annual volume and issues appeared for 1860, 1861 and 1862–63. The work Galton tells us just paid its way, and the idea certainly was, and might still be, a good one. The 1860 volume contained papers by W. G. Clark, Leslie Stephen, John Tyndall and others, besides one by Galton himself². Much of the matter can be read with pleasure and profit to-day. How wonderfully wise in the light of recent experience seems W. G. Clark’s talk with the Frenchman in Genoa over the latter’s view that “there will be no secure and lasting peace for Europe until its political system is based upon the principle of nationalities.” How this search for a definition of a ‘nationality’ might have warned President Wilson of the difficulties and the danger of the creed he was to propound 60 years later at Versailles! The accounts of early Alpine ascents, the Allelein Horn by Leslie Stephen, the Eggischhorn by Tyndall and the attempt on the Matterhorn by Hawkins are all still worthy of perusal. Galton contributed to the first volume a paper on Spain and the total eclipse of June 1860. He went out with a party in charge of the Astronomer-Royal in H.M.S. *Himalaya* and saw the eclipse from La Guardia. This was his first visit to Spain and he saw a good deal of the country, staying in the Pyrenees after the eclipse, and “here that remarkable madness of mountain climbing, to which every healthy man is liable at some period of his life, and which I had always believed myself to have gone through once for all in a mitigated form, began to attack me with extreme severity³.” But while he gives us little account of his mountaineering, he takes up very seriously the question of sleeping or camping out at great altitudes, and gives a very full description of suitable rations for a six-days’ outing, and above all of the knapsack sheepskin sleeping bags⁴ of the French ‘douaniers’ or the frontier

¹ A great mass of material for a new edition was collected for and sent to Galton by the late Mr Howard Collins. It will be found in the Galton Laboratory Archives.

² Galton himself in his list of published papers, Appendix to *Memories*, p. 324, says the *Vacation Tourists* contained two memoirs by himself. I have failed to find more than one.

³ *Vacation Tourists*, 1860, p. 446. Galton became from this date even to the end of his days a frequent visitor to the Pyrenees.

⁴ With his usual desire to test practical efficiency, Galton carried one of these bags 1000 feet above Luchon and spent the night in it during a terrific thunderstorm! While familiar to

watchers against smugglers. With the Basque districts of Spain Galton was delighted. He writes:

“Every act of the people was original—their gait, their implements, their way of setting to work. I looked into many shops—such as tinkers’, blacksmiths’, potters’, and so forth—and came to the conclusion, speaking very broadly, that if any of their patterns were introduced into England, or that if any of ours were made to replace theirs, the change would involve decided incongruity, and lead to questionable improvement. Another subject which struck me at once, and with which up to the last moment of my stay in Spain, I became no less charmed, was the graceful, supple and decorous movement of every Spanish woman¹. It was a constant pleasure to me to watch their walk, their dress, and their manner, as it is a constant jar to all my notions of beauty to see the vulgar gait, ugly outlines, mean faces, bad millinery and ill-assorted colours of the vast majority of the female population that one passes in an English thoroughfare.”

Galton contrasts the peasantry, especially the Basque peasantry of Spain, with the inferiority of physique, manner and address of the upper classes of Madrid society, and with conditions in England, where he tells us that “the higher classes, speaking generally, have the higher make of body and mind and by far the nobler social tone.” But the peasantry in almost every land, if it has been long on the soil, appears to the visitor harmonious and even beautiful—think only of the Italian, the Austrian, the upland Baden and the Norwegian tillers of the earth, each admirable in their own way and each suited by centuries of selection to their own environment. The grace of an autochthonous peasantry, the suitability of their dwellings to their climate, of their clothing to their habits, and their artefacts to their domestic and agricultural needs, impresses us in the same way as the grace of a wild animal, adapted in every instinct and habitude to its native haunts, impresses us if we observe it unawares in its own surroundings.

The reader of Galton’s paper will realise how he was beginning in 1860 to turn his thoughts more to man, and this also may be read between the lines of the account he gives of the public baby-dandle in Logroño:

“In the afternoon, the military were paraded, and the bands played in the square. Of course all the spare population went to see them; but what amused us especially, was the part taken by the nurses and the children, both here and at Vittoria. They came in hundreds, scattered among the crowd. The instant the music began, every nurse elevated her charge, sitting on her hand, at half-arm’s length into the air, and they all kept time to the music by tossing the babies in unison, and slowly rotating them, in *azimuth* (to speak astronomically) at each successive toss. The babies looked passive and rather bored, but the energy and enthusiasm of the nurses was glorious. At each great bang of the drummers a vast flight of babies was simultaneously projected to the utmost arms’ length. It was ludicrous beyond expression.” (V.T. 1860, p. 436.)

Another feature of this travel paper is Galton’s increased interest in meteorology and generally in climate. There is even a touch of it in his description of the corona during the eclipse; he is inclined to treat the

Arctic travellers, sleeping bags had not up to that date been used by Alpine climbers, and Galton at a dinner of the English Alpine Club was toasted as the greatest ‘bagman’ in Europe. *Memories*, p. 190.

¹ In a letter to his mother (July 19, 1860) Galton writes: “I cannot tell you how I enjoy Spain. The people are so civil and nice and *clean*. Italy won’t bear comparison on the score of cleanliness with Spain. Everybody is happy and graceful and well-to-do.” This letter contains an account of the eclipse and a rather brilliant pen and ink drawing of the corona.

corona as a mock halo. His job at the eclipse was to have been the taking of observations with an actinometer¹, but on the day before the eclipse, when the instrument was unpacked, it was found to be broken.

"I candidly confess that a rising feeling of exultation accompanied this discovery; I was not now necessarily obliged to spend the precious three minutes of the eclipse in poring on an ascending column of blue fluid in a graduated stem, and noting down the results by feeble lamplight, but I was free to enjoy to the full the whole glory of the eclipse." (*V.T.* 1860, p. 437.)

Galton decided to sketch the corona and to determine from its effect on colours the exact colour of the eclipse light about which there had been controversy. His account² of the eclipse is worth reproduction in part, if only for the originality of his views on the corona.

"2 hrs. 50 m. Indian yellow, cobalt and emerald green are lower in tone. I can distinguish all twelve colours perfectly. Light much fainter. 55 m. Light far fainter. I made a hole in a paper screen, and watched the crescentic image of the speck of sunlight that shone through it on the floor. The shadows were very dark and sharp. Air cold. 58 m. The numerous pigeons of the place began to fly home, fluttering about hurriedly, taking shelter wherever they could. There was something of a hush in the crowd.

At about 3 h.—I forgot to note the exact watch time, I am sorry to say—totality came on in great beauty. The Corona very rapidly formed itself into all its perfectness. It did not appear to me to *grow*, but to stand out ready formed, as the brilliant edge of the sun became masked. I do not know to what I can justly compare it, on account of the peculiar whiteness of its light, and of the definition of its shape as combined with a remarkable tenderness of outline. There was firmness but no hardness. In its general form, it was well balanced, but larger on one side than the other. It reminded me of some brilliant decoration or order, made of diamonds and exquisitely designed. There was nothing to impress terror in the sight of the blotted-out sun; on the contrary the general effect of the spectacle on my mind was one of unmixed wonder and delight.....The Corona-light sufficed abundantly for writing rough notes and for seeing my colours. Oddly enough, the *burnt sienna* and the *vermillion* alone ceased to be distinguishable from each other. Indian yellow had greatly lost brilliancy. I made a rough sketch of the Corona—it was too manifold in its details and too beautiful in its proportions for me, bad artist as I am, to do justice to it in the short time the spectacle lasted—yet the drawing which I made and which is given here [see Fig. 1, p. 9], is to my mind a fair diagram of this splendid meteor³. I drew it without taking any measurements to guide me, but simply as I would sketch any ordinary object. The uppermost part is that which was uppermost when I drew it. I used no lantern and required none; there was a sufficiency of light. The principal facts were, firstly, that the long arms of the Corona [see Fig. 2, p. 9] do not radiate strictly from the centre, neither are they always bounded by straight lines⁴. The upper edge of *a* was truly tangential, that of *d* and others nearly so; *c* was remarkably curved, and so was the lower edge of *b*, though less abruptly; it was like a finch's beak, and remarkably defined. Secondly the shape of the Corona was not absolutely constant; speaking generally, it was so; but in small details it appeared to vary continually, by a slow diorama-like change. There was no pulsation or variation of intensity, visible in its light. I was particularly impressed by its solemn steadiness.

¹ Galton had previously to his departure been instructed by Sir John Herschel in the use of this invention of his.

² His sketches and other details appear in the Royal Astronomical Society's *Memoirs*, Vol. XLI, pp. 563–4, as well as in *Vacation Tourists*.

³ Elsewhere in this paper (p. 423 "each phenomenon of that strange and magnificent meteor") Galton uses this word in the sense of an unusual atmospheric appearance.

⁴ Even Sir George Airy doubted the curvature Galton gave to some of his rays, but photographs of subsequent eclipses have confirmed the curved rays. There was no photograph of this eclipse, the first probably at which photography was possible, although a photographer was present. He inserted his slide and exposed, but had forgotten to put a *plate into his slide!*

It seemed scarcely possible to believe that the light of the Corona was other than the rays from the sun made visible in some incomprehensible manner round the edge of the moon, the appearance being eminently suggestive of a brilliant glistening body, hidden behind a screen. The nearest resemblance I can think of, to express my meaning (not that I am to be understood as supposing the remotest analogy between the causes of the two appearances), is the effect of a jet of water, playing from behind against some obstacle, and throwing an irregular halo of spray around it, on all sides. That a reasonable foundation may exist for ascribing the Corona to some diversion of the ordinary rays of the sun, however unintelligible the cause of this diversion may be, and not to a luminous atmosphere surrounding the sun, was powerfully impressed on me by certain appearances that were observed when totality was passed: they were these. Four or five minutes after the reappearance of the sun, Mr Atwood called attention to remarkable luminous radiations, like sunbeams slanting through a cloud, and proceeding in narrow but long brushes from the cusps of the sun. They changed their angular directions and even their shapes with such rapidity, that I was almost bewildered in a first attempt to draw them. If I looked down on my paper to draw a few strokes, the appearance had become changed, when

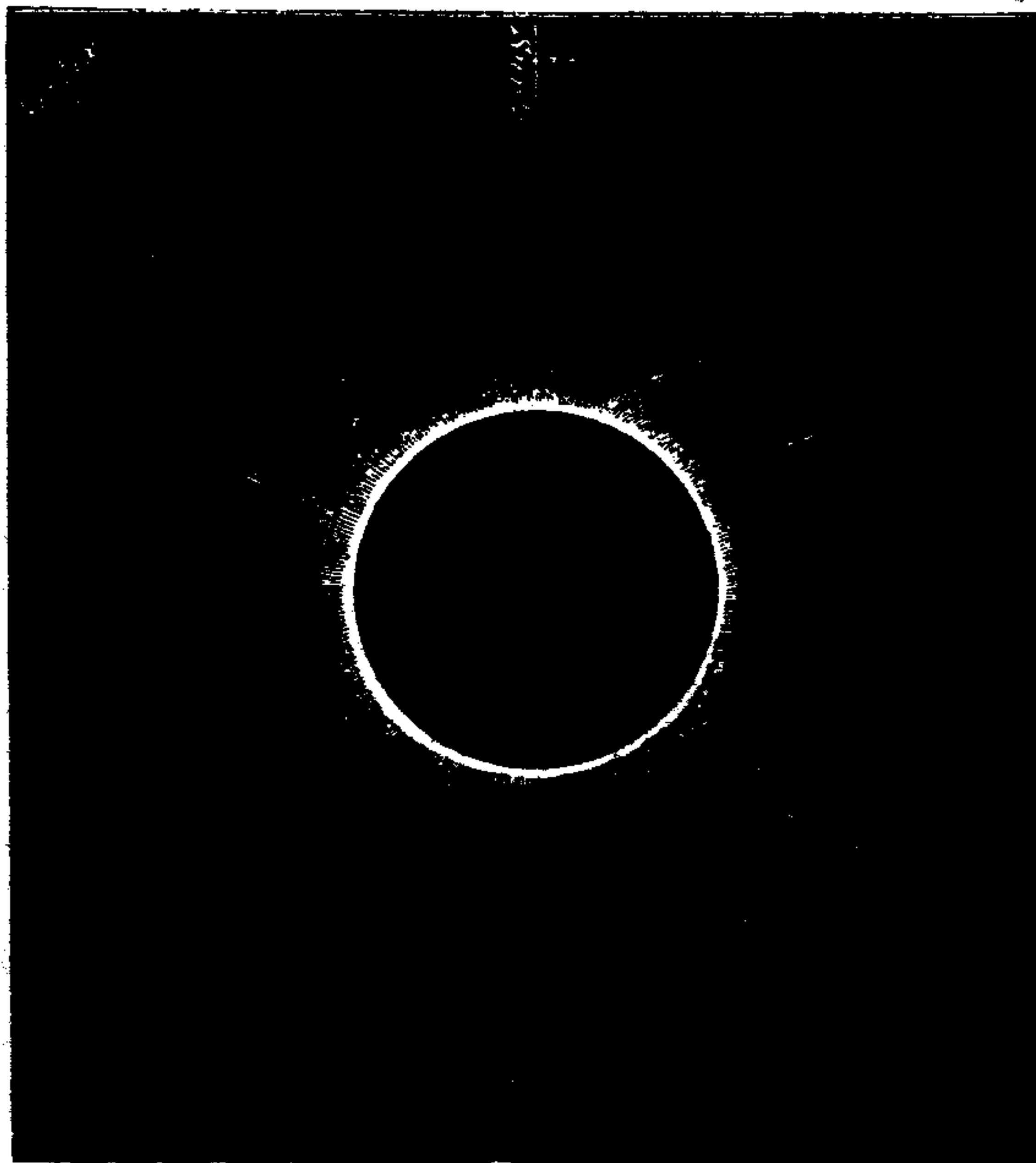


Fig. 1.

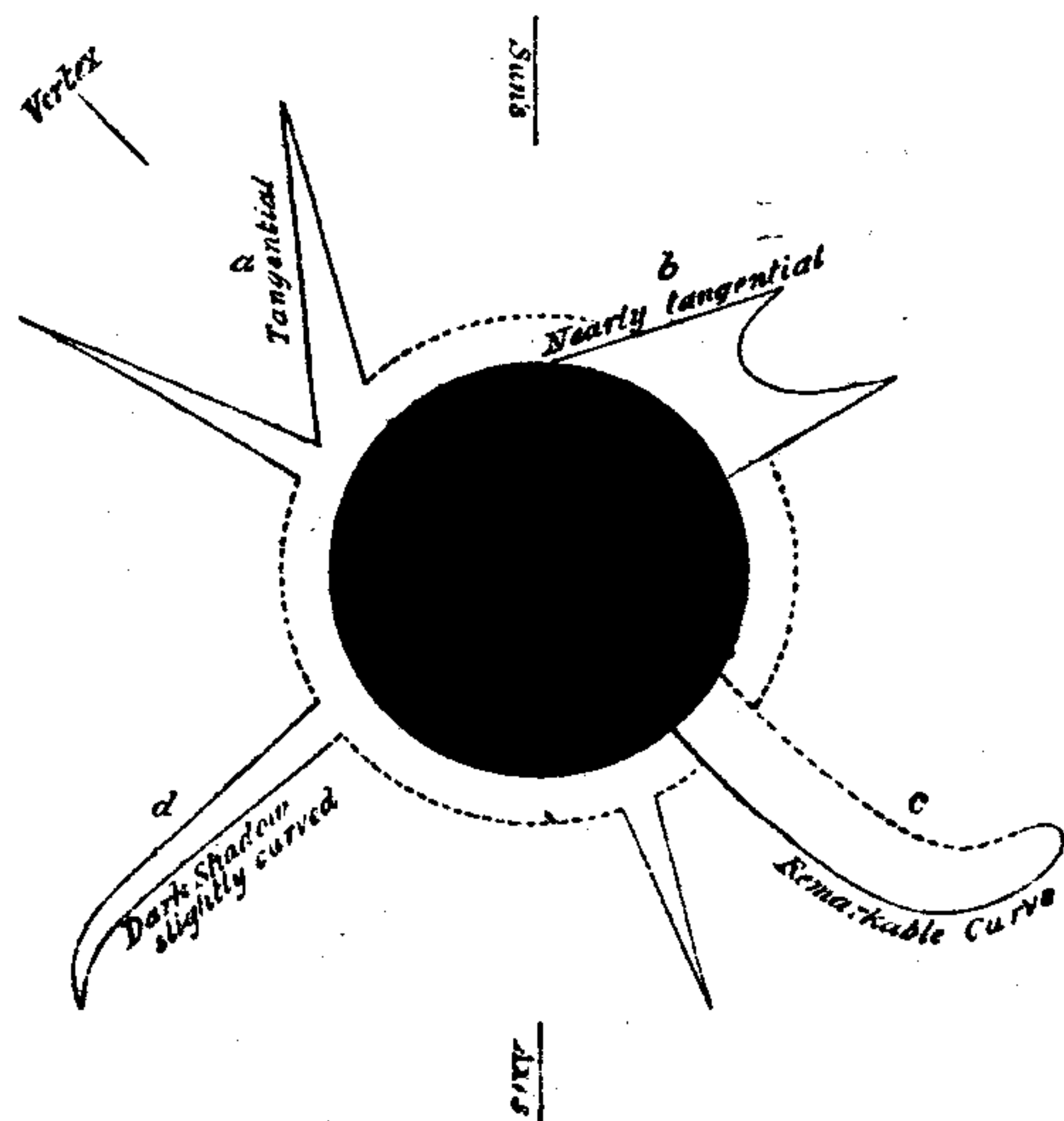


Fig. 2.

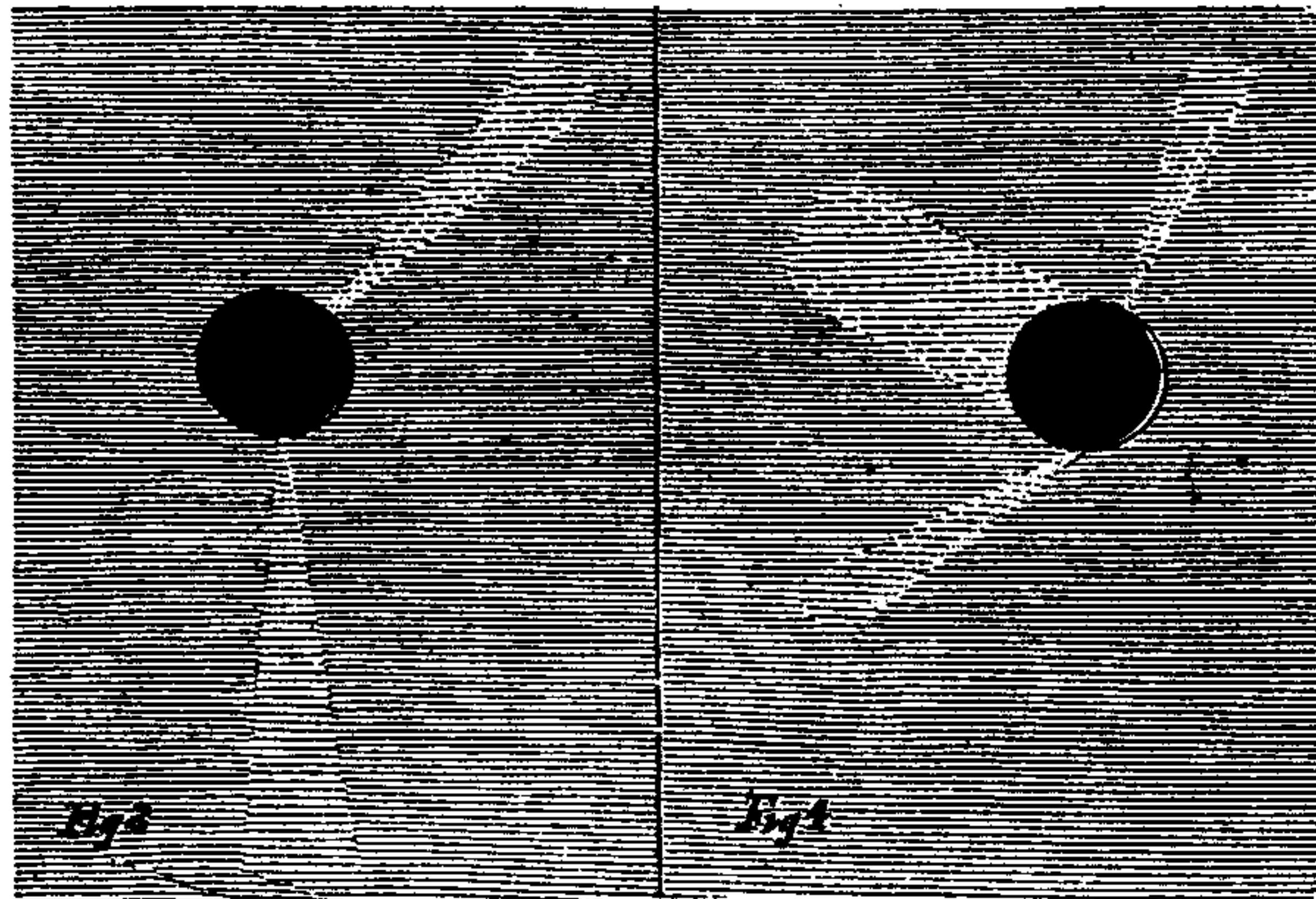
I again raised my head. Nevertheless between 3 h. 11 m. and 3 h. 13 m. I managed to make three sketches; the two that were most characteristic are here very fairly represented. After 3 h. 13 m. the light of the emerging sun was too strong to admit of further observations. The brushes were perfectly distinct and unmistakable, they were best seen by holding up the hand so as to mask the sun, and they were perfectly visible through the telescope when it was so turned as to exclude the sun. There was no mistake whatever about their existence. I trust that the attention of observers of future eclipses will be directed to them, both before and after totality. Now whatever may have been the cause of the brushes, would also, I should guess, be competent to create the greater part of the Corona; the two appearances being of identically the same genus. It will be observed that the brushes in Fig. 3¹ enclose an angle of about 130° , on the side of the emergent sun, and that the same angle had changed to about 195° in Fig. 4, to say nothing of the appearance of a central bar of light. The angular change of the brushes was continuous, so long as I had an opportunity of looking continuously at them.

I have since often looked for, and have only just seen (Sunday Feb. 10th²), an almost precise

¹ See Figs. 3 and 4, p. 10.

² Presumably 1861.

representation of these appearances, in the case of small black snow-laden clouds sailing before the sun. When the clouds are in any way transparent, though some indications of these brushes

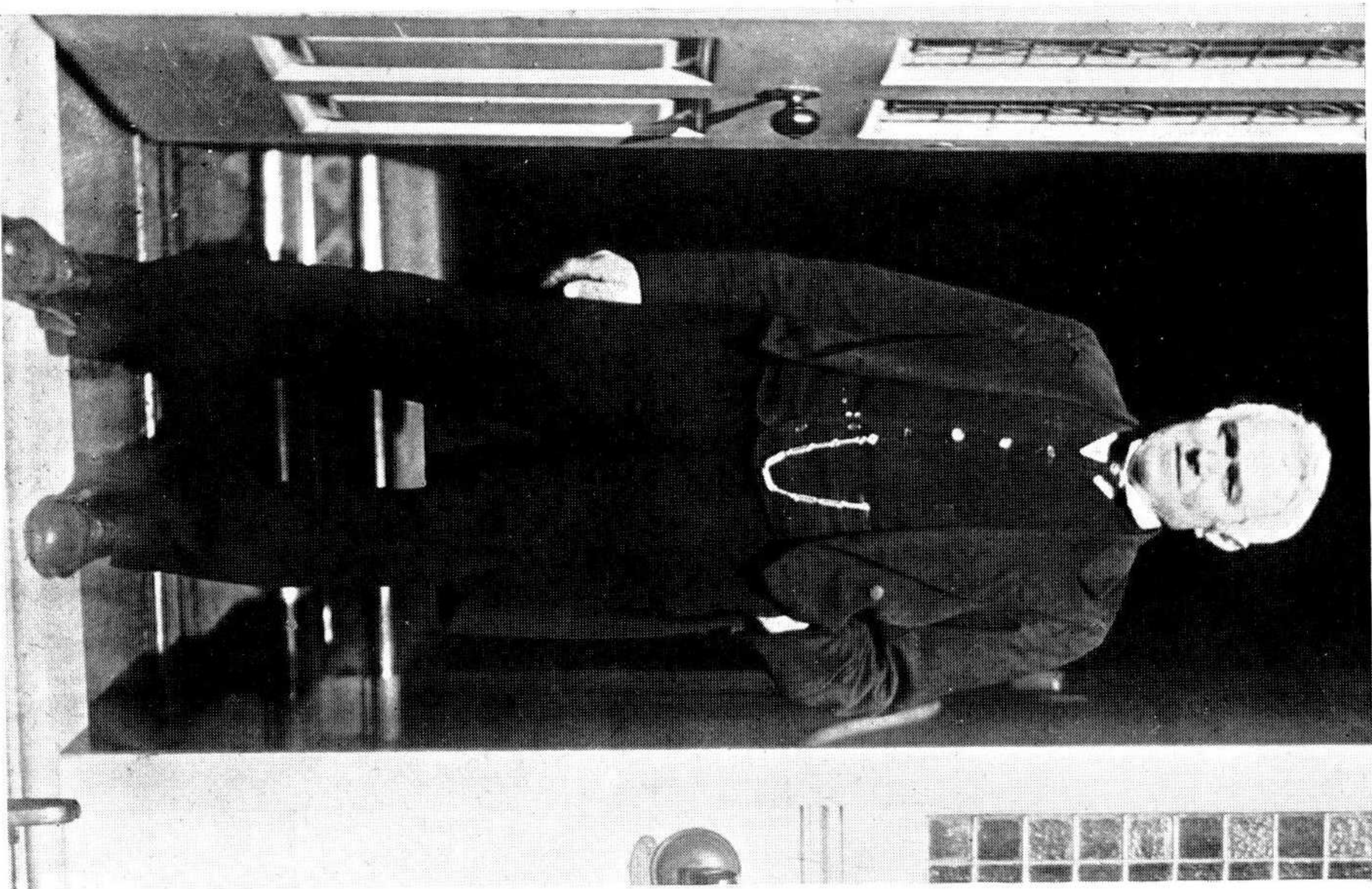


may be observed, their effect is proportionately feeble, and if the sun be masked by an object at no great distance, the effect does not occur at all. The common artist representations of the sun about to rise over a distant hill, show that these appearances are generally recognised. Now I can hardly understand what I have described, on any other supposition than that of sun-beams being reflected from off the back of the cloud at a very acute angle athwart the line of sight. They would illuminate the haze of the atmosphere through which they passed, and being seen exceedingly foreshortened, would be the more apparent. But here I stop. I do not comprehend why the wisps of light should be projected from the cusps of the uncovering sun, and therefore have an apparent movement of revolution. Still less can I understand why the moon, which is presumed to have no atmosphere of any description¹, capable of being illumined by passing rays, should exhibit this appearance so beautifully. When I shall have seen wisps of light, as in Figs. 3 or 4, coming from a cloud, but shaped in any way like those of Fig. 1—convergent and not divergent, curved and not straight—whether owing to irregular distribution of the adjacent haze or other intelligible reason, I shall hardly resist feeling satisfied that the Corona is mainly due to the same description of cause that produces them, whatever that cause may really be. There may, in addition, be some luminous effect produced by an enveloping atmosphere of light round the sun, seen beyond the edges of the eclipsing moon.....

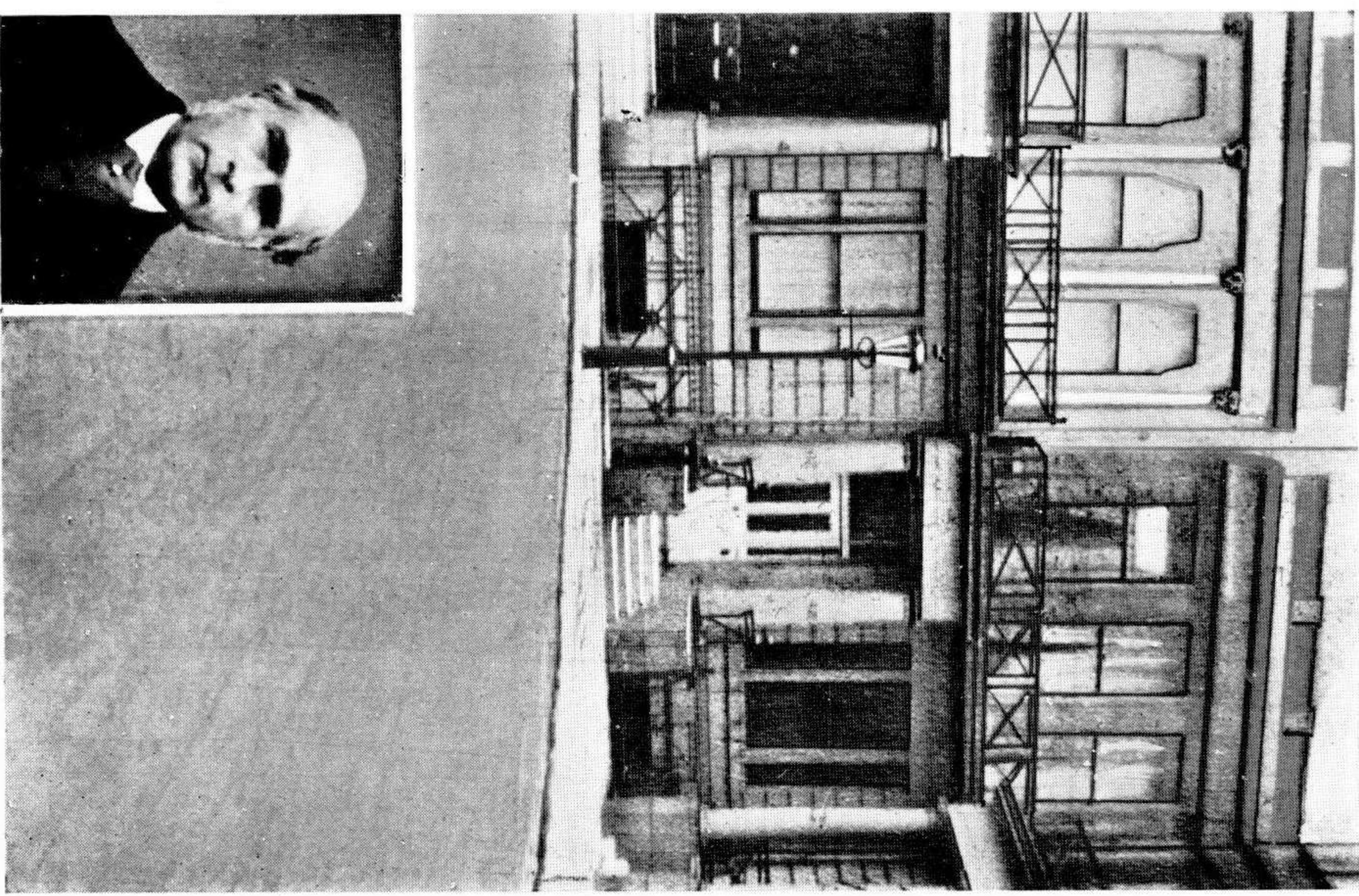
As to my colours: after a good deal of trouble, I find I can reproduce the exact effect that I witnessed, by placing them in a closed box having a dark ceiling, and admitting a faint white light at a low angle. I then view the colours also at a low angle through a piece of dull yellow glass. All these details seem essential to effect: they are in some sort, the equivalents to a yellow sky near the horizon, and gloom above head." (*V.T.* 1860, pp. 440-4.)

We have given this long extract from Galton's paper because it shows not only the working of Galton's mind at the time, but is very characteristic of the general manner in which he approached problems. He thought and reasoned about things for himself even when they might lead him astray. His *curved* corona rays have been confirmed. He alone noted that cusp rays were still visible when the crescent was masked by the hand. Galton's observations (but not his inferences from them) will be found in Ranyard's "Observations made during Total Solar Eclipses" (*Memoirs of R. Astron. Soc.* Vol. XLI, 1879), where his sketches are reproduced (pp. 563-4) in more finished form.

¹ The brushes according to Galton's sketch extended to three times the moon's diameter.



The trusty Giff, Galton's Swiss Servant. ("Mr. Galton is at home, Sir, and has been expecting you.")



42, Rutland Gate, S. W. Galton's home from 1857 to 1911. (House with *white* door.)

Galton himself says¹ of the *Vacation Tourists*, that excision was often an unwelcome duty, and illustrates it by the statement that among the contributions offered for one volume were thirteen separate descriptions of sea-sickness! Yet the volumes have something of the charm of leisurely mid-Victorian journalism; and should not be allowed to pass into complete oblivion.

In 1864 Galton wrote for John Murray² a knapsack guide for Switzerland, which just deserves mention under the heading of travel. It reached a second edition, the one I have examined. The late Mr John Murray paid Galton £150 for the copyright. It was one of a series of four (Switzerland, Italy, Norway and Tyrol) which have since passed out of sight. The general plan is very much what we now associate with Baedeker, and the hints as to hotels and the character of landlords were more or less original in those days. Galton's name is not associated with the work and there is little to identify it with his personality. He does not mention it in the *Memories*; it is omitted in lists of his books and memoirs, and the present writer never heard him refer to it. It is nevertheless a substantial piece of work. How and when did Galton obtain his knowledge of Switzerland? The answer may be found in the brief yearly records of "Frank's Life" and "Louisa's Life" on opposite pages from 1830 to 1853, and then carried on in common by Mrs Galton until her death in 1897, which year is written by Francis Galton himself. From this *Record*³ we find that not only was a considerable portion of the wedding tour devoted to Switzerland (1853), but in 1856 the Galtons were in Switzerland and the Tyrol. In 1857, 1861, 1862 both were again in Switzerland, and in 1863, Francis Galton, probably to complete the knapsack guide, was alone in Switzerland. Thus his experience was fairly ample for a guide which was intended not for the high-peak climber, but for the 'Thalbummler,' or for the tourist in the broader sense.

The autumn travel often extended to two or three months, and the visits to Mrs Galton's family at Gayton or Julian Hill, or to Francis Galton's relatives at Leamington, Claverdon or Hadzor were a constant feature of the Galtons' life; they consumed much time, but had no doubt compensating advantages especially as the health of both was at times indifferent. Beyond these travels and visits social life is often referred to, and the names of the Russell Gurneys, the Gassiots, the Norths and of Spottiswoode begin to appear in the diary. After their return to England in 1853, the Galtons had occupied lodgings in Portugal Street; then they lived at 55 Victoria Street, Westminster, and finally in 1857 they took possession of the house in Rutland Gate, which remained Galton's home till his death in 1911, and is the environment with which most of his surviving friends will chiefly associate him. The light and airy, white enamelled drawing-room, with its furniture of many periods and styles; the long dining-room with its bookcase at the back, Galton's working table⁴ in the front window, and on the walls the prints

¹ *Memories*, p. 187.

² *The Knapsack Guide for Travellers in Switzerland*. New edition revised, 1867. "Frank busy editing Murray's Handbook." *L. G.'s Record*, 1864.

³ In future to be cited as *L. G.'s Record*.

⁴ Now in the *Galtoniana* of the Galton Laboratory with his writing chair.

of Galton's friends—Darwin, Grove, Hooker, Brodrick, Spencer, Spottiswoode¹, etc.; the dark back room with its shelves loaded with pamphlet cases filled with letters and manuscripts, the boxes of models, and the notes of a long lifetime of collecting, mostly indexed by Galton himself, all these will be familiar memories to his friends, and formed a singularly unique environment, very characteristic of the man. A great reference library, one of the principal rooms of the house devoted to a study, reproductions of modern or medieval art, these were not essential needs of Galton's nature. Among his books were no long series of foreign journals or transactions, and but few fundamental treatises on anthropology or natural history. His library consisted chiefly of books which their writers presented to him—such as Darwin's works—or of offprints and papers sent to Galton when his name had become known. There are scarcely two dozen books in Galton's library as we now have it, which we can assert he must have purchased to forward his work. There are masses of measurements and observations of Galton's own, but unlike Darwin he did not start by analysing published material. He collected afresh either directly or through others and formed his conclusions *de novo*. I do not think he ever studied Laplace or Poisson; I am confident that he had never considered the original papers of Gauss; even while Galton's work seems to flow naturally from that of Quetelet², I am very doubtful how far he owed much to a close reading of the great Belgian statistician. He formed no collection of his books, and the few references to Quetelet in Galton's writings are such as might easily arise from indirect sources. Galton took up his problems one after another and worked at them largely disregarding their past history, when indeed they had one. This is only possible in a man of great insight and brimming over with suggestive ideas and novel processes. But the method has some drawbacks, when adopted by lesser men, and even, as in his above-cited account of his observations on the Corona, we may find it open to criticism in Galton himself. But unless my readers grasp this characteristic of Galton's nature they will fail to understand how, with all his travel and the social and executive calls on his time, he was yet able to accomplish so much. It is dangerous advice to give to *every* scientific worker, but it is the only useful advice to give to a young man of genius: Find a little trodden path, and explore it rapidly alone, without regard to the work of others; many precious hours will be wasted if you follow up the spoor of each one who has passed athwart your path before. Galton took some time to find his individual track, but having found it, he went ahead without much regard to forerunners or even to those working on parallel lines. It was this individuality of method which impressed itself on his environment and rendered him so independent of the usual appurtenances of the scholar. He thought and he worked with the simplest of tools, and these mostly of his own making.

¹ Hung at the present time on the walls of the Committee Room in the Galton Laboratory. The family portraits which hung in the drawing-room and Galton's bedroom may still be seen on our walls, and even the quaint stunted cupboard wardrobe from Galton's dressing-room now serves as a store for mechanical calculators—a use which would have delighted his heart!

² In a card index prepared by Galton himself to his books and pamphlets the name of Quetelet does not appear.

I have interpolated this paragraph into our history of the man himself, because while those travels, that social life and that scientific executive work¹ went on continuously, I shall only refer to them again very incidentally, they serve merely as a back-ground to the intellectual life of the man with which we shall in this second volume be principally concerned.

The reader will perhaps have observed that the year 1855 does not occur on our p. 11 as one in which Galton visited Switzerland. It was the year of the Crimean War, a year of grave depression for all those who had the national welfare at heart. The crass ignorance which rules in high places, the criminal want of preparation characteristic of nearly all British executive bodies showed themselves in the general breakdown of 1855, as intensely as they did in 1914, or in the Boer War of 1900. The shame of 1855 is almost forgotten now in the light of more recent impressions. But it led the patriot, man or woman, of those days to cry: "How can I aid this helpless, foolish country of mine? What can I contribute that it lacks? How is this brainless executive to be pushed on to firmer ground?"—And men and women stepped out of their seclusion and their studies in 1855 in their tens, as they did in the last war in their hundreds, and demonstrated that the nation's real strength lay in its reserve of brain-power, and not in its political leaders and the paid servants of the government. The world rung with the glorious work—the almost Joan d'Arc task of Florence Nightingale; the inner circle might know that her greatest services to the nation were not those which caught the public imagination; but the public were right in identifying its ideal with a definite personality, above all with such a marked one as that of the 'Lady of the Lamp.' But at the time of the Crimean War as in recent years there were others also who asked themselves what is my *métier* and how can I supply in one way or another what the nation lacks? Among these self-questioners was Francis Galton.

He heard of the terrible sufferings of our soldiers in the trenches, due in the first place to the ignorance of their officers, men who in the majority of cases had had no experience of bivouac and camp. Galton realised the need of our armies in one way as Florence Nightingale did in another. His own words best express the situation:

"The outbreak of the Crimean War showed the helplessness of our soldiers in the most elementary matters of camp-life. Believing that something could be done by myself towards

¹ Council of the Royal Geographical Society 1854–93, Secretary 1857–63; General Secretary to the British Association (at first with W. Hopkins and then with T. Archer Hirst) 1863–67, President of the Geographical Section 1862 and 1872, President of the Anthropological Section 1877 and 1885; he was twice invited to be President of the Association, 1890 and 1905, but declined on the ground of health and strength. ["They wanted to nominate me as President of the British Association for 1893, but I have definitely declined, as I did for 1891 [1890], being out of my element in dining out day after day, and making speeches, which I detest. Besides I am too deaf to do the ordinary presidential duties well." *Letter to Sister Bessie*, Feb. 13, 1892.] He was Chairman of the B. A. Anthropometric and of the Local Societies Committees in 1883; elected Fellow of the Royal Society 1860; Member of Council 1865–6, 1870–2, 1876–7, 1882–4, and Vice-President in the last three series, Member of the Kew Observatory Committee 1858, Chairman on the death of De la Rue 1889 until 1901. Meteorological Committee 1855. Meteorological Council 1901. President of the Royal Anthropological Institute 1885–88; Chairman of the Royal Society Committee on Evolution 1896, etc. etc.

removing this extraordinary and culpable ignorance, I offered to give lectures on the subject; gratuitously, at the then newly-founded camp at Aldershot. As may be imagined from what is otherwise known of the confusion of the War Office at that time¹, no answer at all was sent to my letters, until I ventured to apply personally to the then Premier, Lord Palmerston, who at once caused me to be installed. It is evident from my old notebooks that I worked very hard to frame a suitable course of practical instruction and of lectures for those who cared to profit by them²."

¹ Rather at all times. The War Office should have inscribed over its portals: *Crimea, 1855; South Africa, 1900; Flanders, 1914;* with a blank space for its future achievements.

² *Memories*, pp. 163-4. I have found a printed document in our *Galtoniana*, marked "Printed for Private Circulation only," which is probably the actual form of Galton's request to the War Office. It is dated 4th May, 1855 and is entitled *Ways and Means of Campaigning*. It begins:

"The helplessness of our soldiers, when they are thrown for awhile upon their own resources, has been so frequently insisted on and deplored in the Evidence taken before the Sebastopol Committee, and in speeches in both Houses of Parliament that, while it becomes impossible to doubt it as a fact, there arises a serious question whether, and in what way, we should attempt to remedy it.

"Now as matters bearing upon this question have been my special study in extended travel, so far as to have induced me to write upon them, quite irrespectively of the present war, I thought myself justified in communicating to the military authorities a scheme that I had matured to meet the present occasion, and, whilst my proposal remains under consideration, I embrace the opportunity of putting what had been scattered over many pages of writing, at different times, into the present condensed and legible form.....I have offered my gratuitous services in organising a SCHOOL OF INSTRUCTION in such of the ways and means of campaigning as fall under the following heads: 1st The best of those **MAKESHIFTS AND CONTRIVANCES** which those people adopt who have been thrown on their own resources in all parts of the world. 2nd The elements of those **HANDICRAFTS** which experience has shown to be most needful in those circumstances.

"My wish is to reduce the teaching of these matters to a regular system. I am quite convinced it can be done, and that an interesting and very useful course in them could be afforded to the army generally, at a very small cost and without clashing with their regular duties. I seek for an opportunity of proving this practically. If I succeed in doing so to the satisfaction of our military rulers, they might extend the system as widely as they pleased, and my classes would have instructed a number of persons who would afterwards be qualified to teach. As yet the matter is a novelty; no one can point to experience and say: 'These things are the best to be taught—this the best way of teaching them—such is the time required for a good practical instruction—such the likelihood of the course being a popular one.' But if the experiment has been once set on foot, even so short a period as two months, would go far towards deciding these points, and affording sound ground for future plannings."

Then follows the suggestion of beginning at Aldershot and a summary of what the contents of the course might be, and the paper ends with a sincere hope that the Military Authorities may think fit to countenance a scheme which requires a mere trifle of material support.

The *Times* of September 25, 1855 devoted two columns to Galton's work on travel and campaigning in a very sympathetic spirit. "The camp of Aldershot" it wrote "at this moment is the scene of a remarkable experiment. Mr Galton, a gentleman of considerable experience in the shifts and contrivances available for travelling in wild countries, has obtained the permission of Lords Panmure and Hardinge to tenant two huts with an enclosure adjoining for the purpose of communicating his experience to the British soldier. His services are rendered gratuitously at present, for his arts are untested and his teaching is a novelty. But the day will perhaps come when their value will be recognised and he himself be duly installed as our first Professor of Odology [? Hodology]. *A priori* we should say that a traveller may be competent to supply a void in military education. A soldier, like a traveller, may be thrown upon his own resources, but without having acquired a traveller's self-dependence. In such circumstances he may eventually obtain the knowledge which is prized as the qualification of an old campaigner, but necessity will be his teacher and his apprenticeship will be cruel.....*Au reste*, whatever his success may be in his immediate undertaking Mr Galton has the merit of having

General Knowles then in command gave Galton all the aid in his power, two huts were placed at his disposal and he took a small house, Oriel Cottage, two miles away and walked to and fro daily to his work. He started in July and, except for a short visit to Paris in September, continued to lecture until the following spring.

The syllabus of Galton's lectures in 1856 lies before me, and on p. 16 is shown the first page. The Lectures were to be illustrated by Pictures, Models and Experiments.

"*Water* deals with methods of finding as well as using (purifying and filtering) and carrying, greased canvas bags, skins, etc. *Fire* with 'Lucifer matches,' burning glasses, fire-sticks, sulphur matches, etc. *Bivouac* with natural and artificial screens, sleeping bags from blankets sewn along edges, sleeping when in urgent danger, etc. *Food* with proper proportions of fat and meat, cooking, grinding, preserving, fishing, game, etc. *The March*, watching, hearing, tracking, scouting, prisoners, sore feet and drying clothes. *Rivers and Bad Roads* with temporary bridges, fords, swimming cattle and waggons, rafts, rough boats, steep pitches and waggon brakes, etc. *Crafts and Mechanics* with felling timber, seasoning, making axles, lathes, bending wood, case hardening, fuel, turning, soldering, rude capstans, pulleys, knots, etc. *Animal Products* with bones, horn, catgut, bladders, hair, shells, hides, charcoal, glue, oil, candles, soap, etc. Next we learn about writing materials, substitutes for paper, and ink, secret writing, inscriptions for secret information, conveying letters, etc. *Animals of Draught and Burden* deals with hobbling and tethering, watering of cattle, nosebags, pack saddles, saddlery, waggon harness and waggon-mending, accidents to waggons and animals, etc. *Tents and Hutting* describes various kinds of tents and material, best place for pitching, action of rain and dew on tents, huts rude and more elaborate, whitewash and plaster, seats and tables, windows, floors, etc."

Much of this syllabus, which I have given in very abbreviated form, will be familiar to the reader of the *Art of Travel*, but the matter was adapted to the special needs of the army and to a special audience.

Galton writes in his *Memories* (p. 164) with undue modesty of the attempt he made in 1855-6 to teach the soldier the art of campaigning which at that time appeared to form no part of the military curriculum¹. The sluggish War Office at last seems to have recognised its value, for two years after the war was over it caused to be constructed and distributed to various centres ten sets of cases of models and specimens illustrative of Galton's lectures to be prepared after the design of a set which he himself had made and presented to Woolwich. These cases of models were accompanied by a catalogue of 20 pages prepared by Galton himself, this being an enlargement of the above-mentioned syllabus. In the preface he writes:

"It is trusted that they may not only serve to interest and instruct the soldier, but especially to suggest to officers, who take an active part in educating their men, the precise subjects on which practical classes in the Arts of Camp Life may most usefully be employed.....An old framed a code of rules for situations in which Englishmen of all men are most apt to find themselves. The most popular type of an Englishman ever conceived is that of an isolated self-relying unit; and for this individual Mr Galton has formed a manual, which he might properly term 'Robinson Crusoe made Easy.' He offers a consistent rule of life to the vagabond, and settled principles to the restless wanderer. In this sense he converts the savage into the sage and makes the whole wilderness blossom with his red handbook [i.e. *The Art of Travel*]."

¹ I have before me the list of officers and others who attended his lectures in July, August and September 1855, and if the lectures after the first were not crowded, the total number who attended was not insignificant. Galton had never had the training that an academic teacher acquires, and his formal lectures, at any rate in his later life, were not as good as his talks and demonstrations.

ARTS OF TRAVELLING AND CAMPAIGNING

THE FOLLOWING
COURSE
OF
PUBLIC LECTURES
WILL BE DELIVERED AT
THE CAMP AT ALDERSHOT,
BY

FRANCIS GALTON Esq., F.R.G.S.

Author of the "Art of Travel" and of "Explorations in Tropical South Africa"

The Lectures will commence at HALF-PAST SEVEN, and will be delivered on WEDNESDAY Evenings, as follows:—

<i>Page</i>	<i>Subject of Lecture</i>	<i>Day</i>
3,	Water for drinking	Jan. 16
4, 5	Fire. Bivouac	Jan. 23
6,	Food	Jan. 30
7, 8, 9	The March. Rivers and bad Roads	Feb. 6
10	Crafts and Mechanics	Feb. 13
11, 12, 13	Bush Manufactures	Feb. 20
14	Animals of Draught and Burden	Feb. 27*
15	Tents and Hutting	March 6

Mr Galton will also be present in the Lecture Room, from 10½ to 12 o'clock, on the THURSDAY Mornings, where he will be happy to explain any matters connected with the Lecture of the preceding Evening; and to repeat it at 11 o'clock, in the event of there being a sufficient attendance.

LONDON

PRINTED BY T. BRETTELL, RUPERT STREET, HAYMARKET

1856

* Had Galton overlooked that 1856 was Leap Year?

campaigner's acquirements consist partly in knowledge and partly in handiness. Field lectures, illustrated by experiments, may convey the first to an intelligent novice, and these models will explain what kind of things must be made by his hands, before he can acquire the latter.

FRANCIS GALTON.

42 Rutland Gate¹,
April 5, 1858."

Only one of Galton's Aldershot lectures, the inaugural one "on the opening of his Museum and Laboratory in the South Camp, V. Nos. 18 and 20," was, I believe, printed. It was issued by John Murray in 1855 as "Arts of Campaigning, an Inaugural Lecture delivered at Aldershot." From this lecture it would appear that one of the huts was turned into a museum, illustrating by sketches and models and a small library the arts of campaigning; it was open from 1.30 to 6.30; the second hut was a workshop, and a place for storing tools.

"Next as regards teaching the *hand*. I am collecting a motley stock of very simple tools and raw materials, planks, logs, twigs, canvas, cloths, and everything necessary for making with the hand those very things that you will see pictured in the museum; I urge you to come and make use of them. In the palisaded plot of ground, between the huts, you can sit and work just as roughly as you would in the Crimea, and you will from time to time have intelligent workmen to assist you in your difficulties, and explain the use of the tools you work with. . . . There is no habitable country so wild and so inhospitable as not frequently to afford ample materials for making each thing I have mentioned. But unless we learn to draw our supplies from nature, and not through the medium of manufactories, we may sit with our hands folded in unwilling idleness, and complaining of want when we are really in the midst of abundance, and surrounded by opportunities of using them. . . . I hope that these huts may be looked upon more as a laboratory where learners may teach themselves, which is the best kind of learning,—rather than as a place where they are formally taught. I wish to make it a kind of head-quarters of the knowledge of those shifts, contrivances, and handicrafts that are available in camp life; and I call upon you to help me with your assistance. Write to your friends from the Crimea, or from the bush, who take an interest in these things, get hints of original experiences from them, and communicate them to me; they will not lie idle, but will at once be turned to account in increasing a store already large, and will remain recorded in pictures or in models for the good of ourselves and all who follow us."

Throughout Galton exhibits his innate modesty; asking for help rather than offering to teach, he proposes expeditions to distant points of the heath to illustrate camp contrivances. He endeavours to give a thoroughly practical turn to his instruction, avoiding scrupulously all that was simply fanciful.

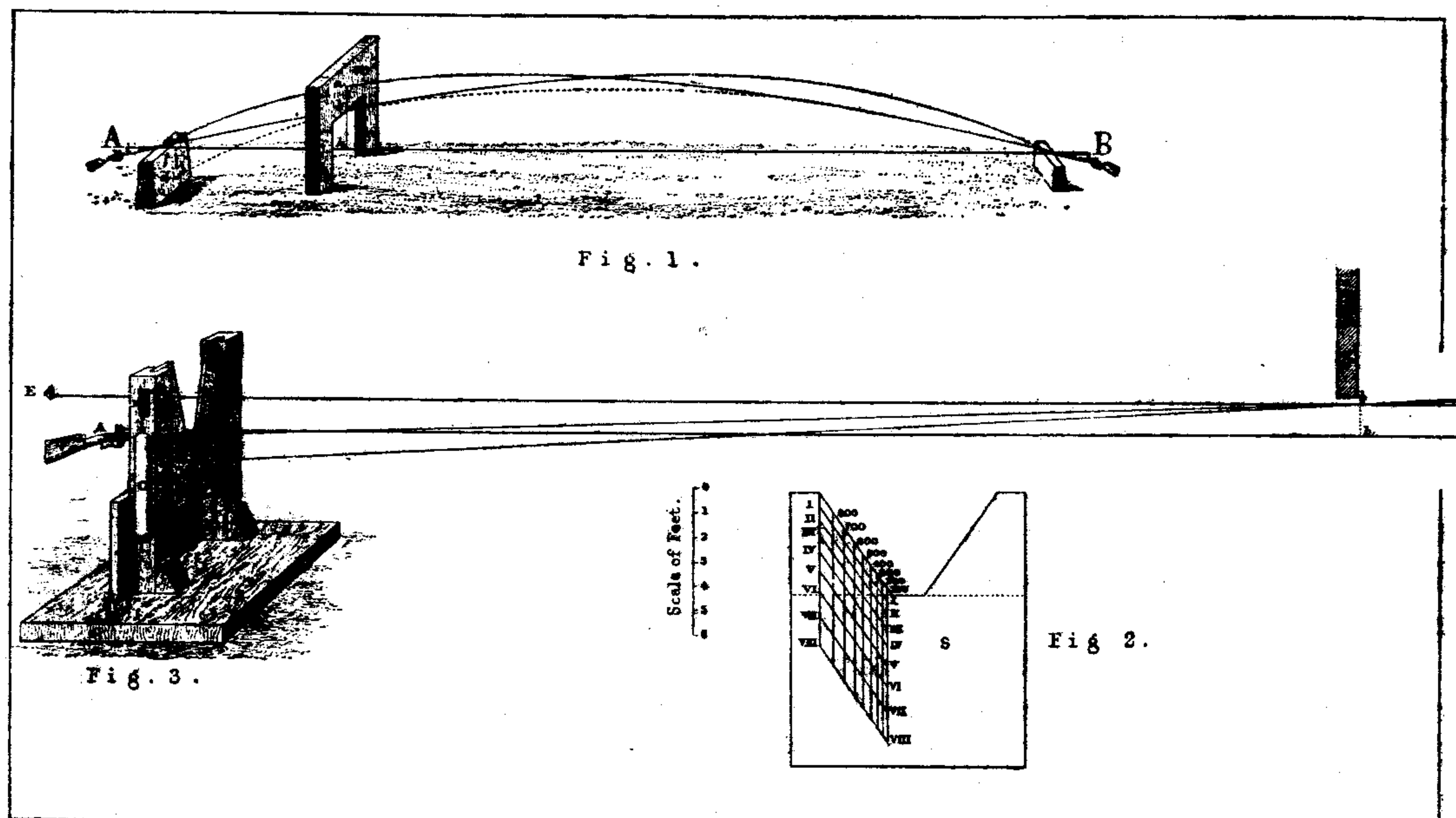
About the same time as these lectures, but at a date unknown to me, Galton gave a lecture on the Art of Campaigning at the United Services Institution in Whitehall Yard. On this occasion according to the *Times* report (cutting without date) "there were present many wounded officers from the Crimea, and the gallery was filled as usual with non-commissioned officers from the Guards, Artillery, Household Cavalry and other troops forming the garrison of London and Woolwich." Galton showed experimentally how a tree might be cut down and turned into a pole without tools and a hole dug in the hardest ground for it without a spade or other tool than a small stick or iron ramrod. He lashed a common clasp-knife to a

¹ This is the first published paper dated from Rutland Gate.

piece of wood and made a spokeshave and so obtained shavings to make a very comfortable bed. Further he explained and demonstrated experimentally how a tent peg might be fixed in loose sand drift to give a resistance of 70 to 90 lbs., etc. He was reported as having been listened to with great attention.

In 1912 one of Galton's cabinets of "Models illustrative of the Arts of Camp Life," which had found its way to the South Kensington Museum, was transferred to the Royal Geographical Society, where it still is, an object of interest in the museum, if hardly of study; whether any of the others have survived I do not know. Probably Galton's activities to some extent helped to relieve the situation in the Crimea, and doubtless had his work been done in 1917 instead of 1856, he would have been offered an O.B.E.

Two memoirs by Galton probably arose from this association with military campaigning. The first is that describing his invention of the Hand Heliostat, an instrument for the purpose of flashing sun signals¹, and the second "On a New Principle for the Protection of Riflemen²." The latter would have been more effectual with the spherical bullets and the lower muzzle velocities of those days than with modern trajectories; it depends on the well-known fact that owing to the resistance of the air, the trajectory of a shot is not symmetrical about its highest point, and accordingly a shot fired from *A* to *B*, and another from *B* to *A*, do not follow the same curve. It is accordingly possible to intercept one of these and not the other by a properly placed screen.



¹ *British Association Report*, 1858, part II, pp. 15-17; also with diagram in *The Engineer*, Oct. 15, 1858, p. 292; *R. Geog. Soc. Proc.* IV, 1860, pp. 14-19.

² *United Services Journal*, 1861, Vol. IV, pp. 393-6.

Fig. 1 (p. 18) explains, of course without the details, Galton's idea. I do not know whether it was ever dealt with experimentally; the extremely flat trajectories of modern bullets, the fact that *A* would have to protect himself not against a single rifleman at a definite range *B*, but against a number of riflemen in different and only vaguely known positions, tells against the method. Even in the case of a single opponent *B*, the latter might, by shifting his position somewhat, actually use *A*'s protection as a protection for himself. Still it is conceivable that the method might be of service in trench warfare, when the ground in front had been accurately ranged, and the danger of drawing artillery fire by the screen had been if possible overcome.

Galton's other paper, namely on the heliostat, is of more direct interest as indicating the mechanical bent of his mind. He had been interested in heliostatic work since his Long Vacation reading party at Keswick in 1841 when he

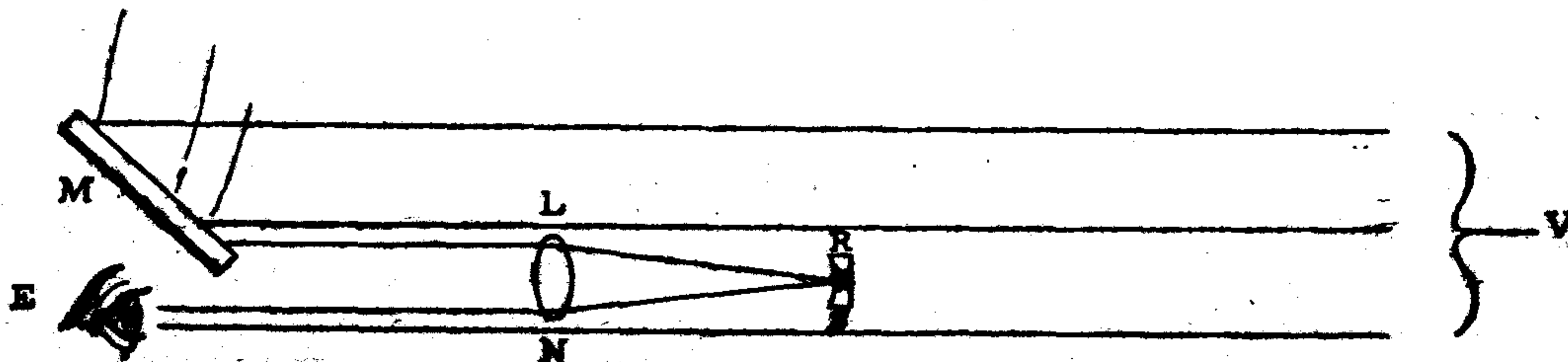


Fig. A. From Galton's original drawings for his heliostat. Diagrammatic figure indicating how the mock-sun is formed and seen covering a portion of the field of view at *V*. The small screen *K* only intercepts a small portion of the field of view. Cf. Fig. 1, p. 20.

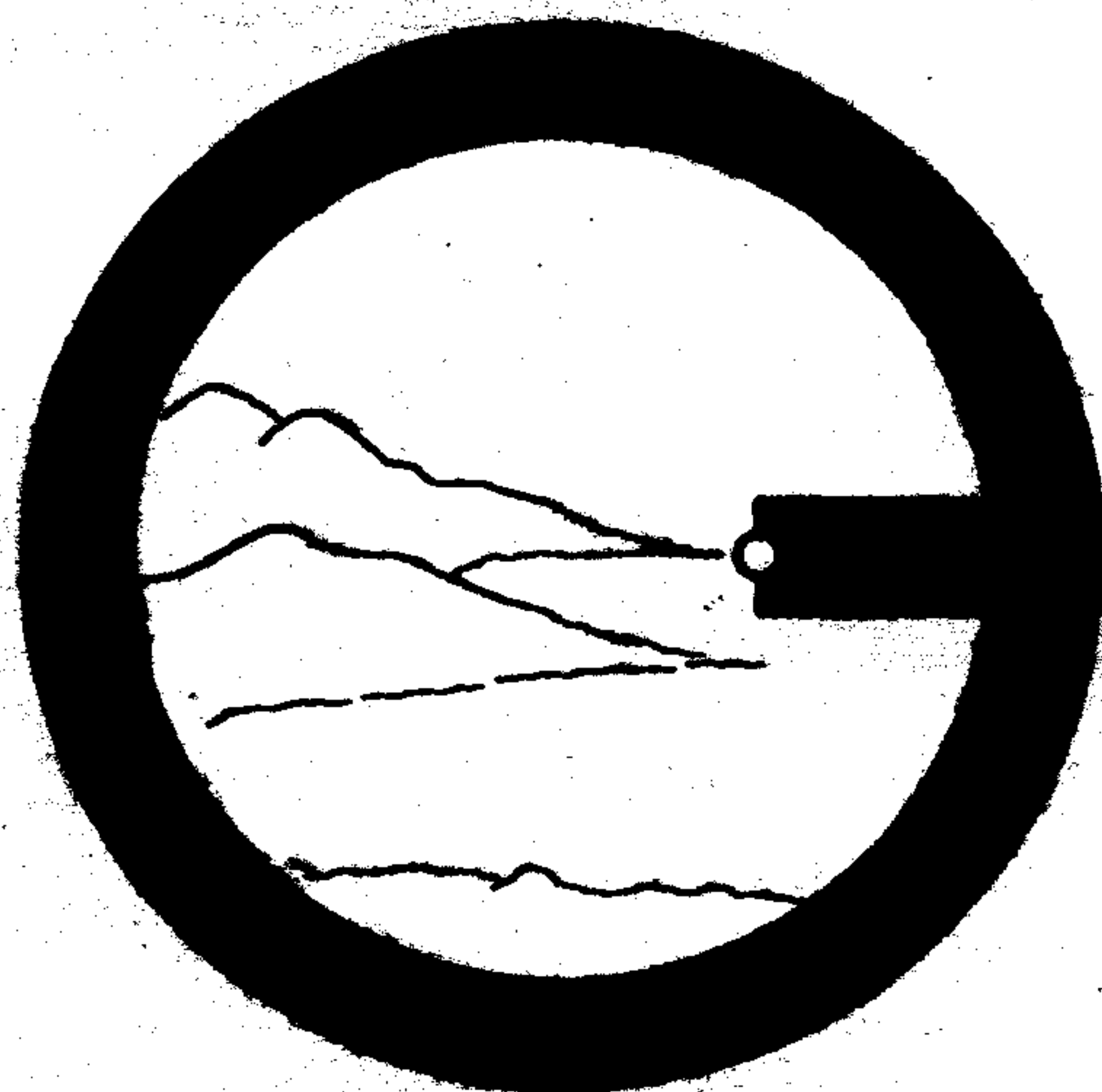


Fig. B. From Galton's original drawings for his heliostat. Field of view of the telescope with the mock-sun covering the point of a promontory to which the instrument would flash light.

found on the top of Seawfell a party of ordnance surveyors endeavouring to get into touch with Snowden and obtain its bearing by aid of a heliostat¹. Galton's ambition was to construct a pocket heliostat and he spent much time in preparing models, of which the Galton Laboratory possesses almost

¹ *Memories*, p. 61.

as many as it does of his 'hyperscope,' a forerunner of the modern periscope¹. Galton's hand-heliostat while described in 1858 in a form which he himself carried in a large waistcoat pocket and which he considered efficient up to ten miles and said would on many occasions have been most valuable to him in Damaraland was, in a larger size and with a stand, ultimately manufactured by Messrs Troughton and Simms under the name of *Galton's Sun-Signal*. According to the former Admiralty Hydrographer, Sir William Wharton, it was used quite recently in nautical surveys to enable shore parties to make their exact whereabouts visible to those on the ship². The principle on which Galton based his heliostat is a fairly simple one. He intercepted a small part of the flash and by aid of it created an image of the sun in the field of view of a telescope; this image was then thrown on any required point of the landscape, and when so thrown any one at that point would see the flash. In his paper to the British Association 1858, Galton describes his own rough model³ which he says any carpenter could make for four shillings, indeed the tube was of wood, the lens a convex spectacle glass, and there was a piece of good looking-glass $3'' \times 4\frac{1}{2}''$. The mirror turns on an axis perpendicular to that of the tube, and the lens partly in and partly out of the tube brings a portion of the flash to a focal image of the sun on a small screen inside the tube. When the image of the sun covers the point to which the flash is to be sent, then the flash will be seen at that point.

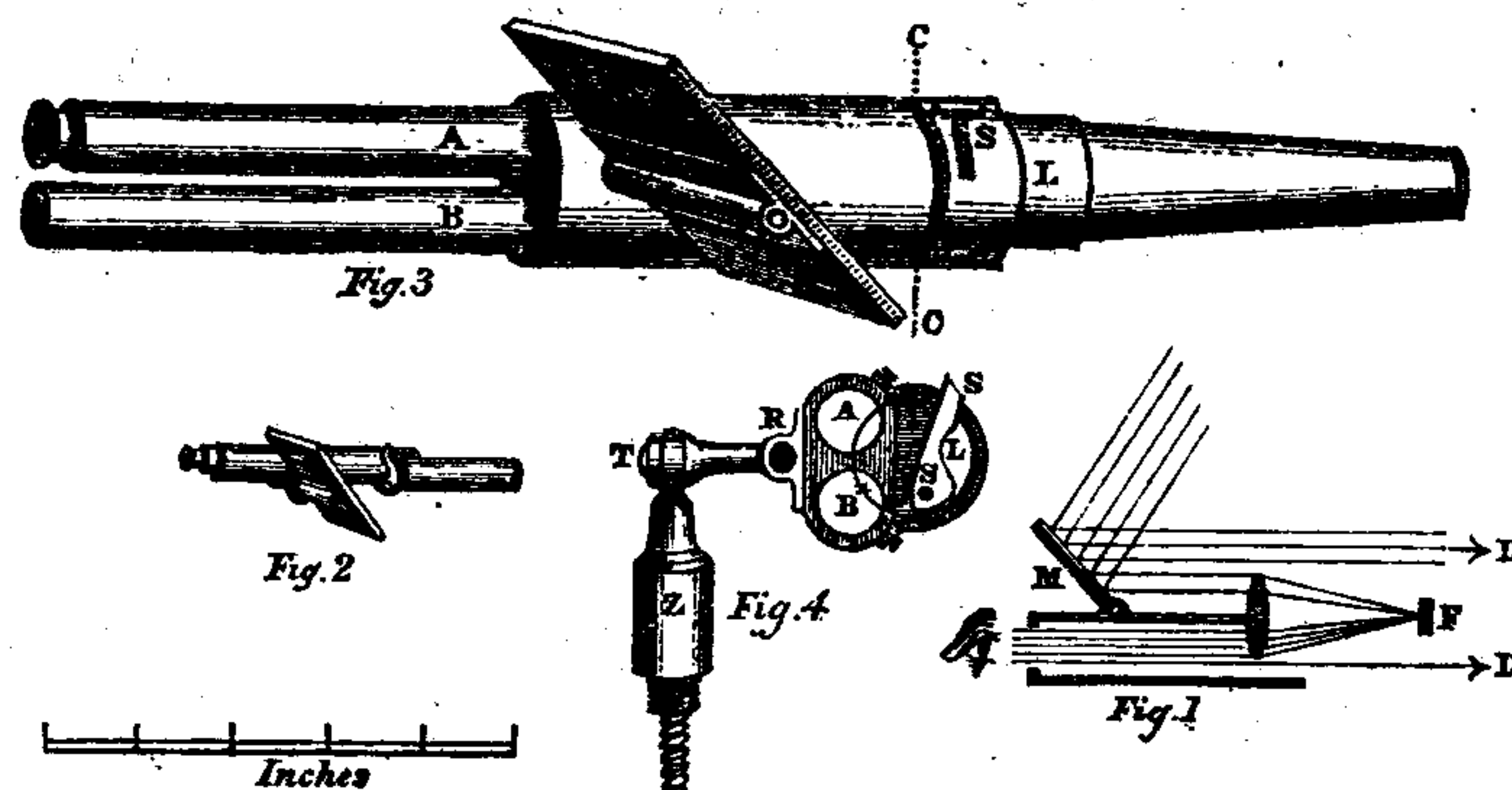


Fig. 1 explains the working; *M* is the mirror with the sun's rays falling on it and reflected in direction *D*, *F* is the screen at the focus of the lens, which is seen by the eye as superposed on the object at *D*. Fig. 2 is a simple pocket form; Fig. 3 a more elaborate form, which has a theodolite telescope *A*, and a plain tube *B* as a finder. Fig. 4 shows the section of Fig. 3 at *C* with a holder which can be screwed on to a camera tripod. A fairly

¹ Both are arrangements of parallel mirrors set at an angle of 45° to the axis of a square tube (generally of card!) with a hole in the opposite walls facing each mirror. Galton designed them in order to see a ceremony over the heads of a crowd or to inspect what lay beyond a high wall. The instrument has also been called the altiscope, and the principle of the modern periscope of the submarine is identically the same. Hyperscopes, probably not under this name or with any knowledge of Galton's early work, were used in the trenches in the course of the recent war.

² *Memories*, p. 165.

³ In the Galton Laboratory.

full account of the instrument is given in the paper of November 28, 1859, on "Sun-Signals for the use of Travellers," and ample directions for its use are provided in the instructions for Galton's Sun-Signal in the larger size which accompany the instrument as it was made by Messrs Troughton and Simms.

Two other researches belonging to this period (1860-62) exist among Galton's voluminous papers. I do not think they were ever printed. In the first he considers the bulk of gold in the world—i.e. in currency, ornaments, etc. This in 1800 was estimated at £225,000,000. Galton computes the volume of pure gold therein and concludes that it would occupy 3053 cubic feet. "Hence my room without extra window space, but disregarding curve at corners of cornice, would hold more gold than was extant in 1800 by 94 cubic feet."

The second paper contains a suggestion of how to reach a decimal coinage for England by the introduction of two new coins, the 'mite' or 'quint,' a fifth part of a penny and the 'cent' or 'groat' of 12 quints. The groat would thus be $\frac{1}{60}$ of a pound, and the florin = 10 groats the intermediate link. The object of the mite or quint was to get the existing coins in easy terms of groats and quints. Thus:

one penny	threepence	sixpence	one shilling	two shillings
= 5 mites	= 15 mites	= 30 mites	= 60 mites	= 120 mites
	= $1\frac{1}{4}$ cents	= $2\frac{1}{2}$ cents	= 5 cents	= 10 cents

Galton put his scheme before Archibald Smith whose gravest objection against it seems to have been that the smallest ultimate divisions were not but ought to be binary.

B. GEOGRAPHY

While Galton was thus turning his travel experience and his study of the works of travellers to national use, he did not overlook geographical research. In 1855 he had contributed a paper of thirty pages entitled "Notes on Modern Geography" to a work issued by Messrs Parker and Son entitled *Cambridge Essays contributed by Members of the University*. I have not succeeded in discovering the real origin of this work, but if all the essays came up to Galton's in suggestiveness, it must be a matter of regret that it has passed out of recollection. Galton's aims with regard to geography were of a three-fold character, namely: (a) to encourage geographical research by travel, and to make it easier by suggestion of methods and instruments to travellers, (b) to make geography a school and academic study, and (c) to revolutionise and humanise maps. The object of the essay just referred to was undoubtedly to popularise modern geography, but throughout his interest in the improvement of maps is dominant.

"There is usually" he writes¹ "as great a difference in geographical value between an ordnance map and, it may be, a beautifully engraved, popular one, as there is in poetical merit between a copy of Shakespeare and a gorgeously bound volume of the vilest trash that was ever published by aid of titled interest and half-extorted subscriptions."

¹ *Loc. cit.* p. 91. The *Cambridge Essays* were issued from 1855 to 1858; their pages excluded 'scientific' subjects according to the preface (? written by the publisher) so that they might

But Galton wanted more than the accuracy of the ordnance map, he wanted a pictorial map, a bird's-eye view of a coloured model.

"It is hardly to be expected that travellers should always find it advisable to draw up for publication large pictorial charts of the routes they have travelled, but duplicates of their sketches and surveys would be a very valuable acquisition to the records of Geographical Societies, where they could be studied by map-makers, who wished to compile a pictorial chart of the country in which they lay. It would, I should think, be a very interesting task to endeavour to map a district on this method, and the result would be sure to be a gratifying one, if the traveller had the eye and the touch of an artist¹. The strictly accurate, but meagre information that is afforded to a student by ordinary maps is more tantalising than satisfactory. A blind man fingering a model could learn as much from his sense of touch alone, as they convey to our eyes. They are little more than an abstraction, or a ghost of the vivid recollections with which the memory of the traveller is stored, not that these recollections are very varied or shifting—one image succeeds another in rapid changes—but that the somewhat stereotyped survey which the mind recalls when it attempts to image to itself the features of a once-visited country, is a matter of colour and blaze of sunshine, and dancing waters and quaint crags or well-marked headlands, and here and there stretches of level land clothed with russet forests or lying open in tawny plains. It is surely not too much to expect that at least some allusion to these features—which are everything to the memory, which are precisely what every traveller whom we address is mentally referring to as *his* map, whilst he answers our questions—should find a legitimate place even in the highest and driest system of topography²."

In short Galton wanted geological and vegetational information added to the maps then in vogue, and he thought it possible to combine a graphic picture with a sufficiently faithful ground-plan. He had great hopes from the art of colour lithography then being rapidly developed³. Galton's senses were keenly alive when travelling and he remarks in this paper that France, Switzerland, Germany and almost every European country has its pervading smell, and its pervading sounds, all widely alien to the experiences of our own mother-country. It was something of the impressions of all this local colouring which Galton found so painfully missing in maps.

"be made intelligible and interesting to the general public of educated men" (!). In the first volume, besides papers by Galton's friends Charles Astor Bristed, the American (see *Memories*, p. 77), and Charles Buxton (*Ibid.* p. 69), there were papers by Liveing, Fitzjames Stephen, and W. G. Clark (*Ibid.* p. 70), also a close intimate of Galton. The *Essays* thus were the product of Galton's close contemporaries, if they did not actually spring from his entourage. I have failed to find who really set them going.

¹ Galton refers in this matter to popular coloured bird's-eye views of the Crimea and Baltic, poor in execution, but supplying a distinct want. He notes also Ziegler's geological maps.

² *Loc. cit.* p. 97. Eighteen years later a letter to George Darwin shows that Galton's thoughts were still working on the same lines. After referring to projecting mouldings on maps to represent mountain chains, modelling from successive contours, Galton continues:

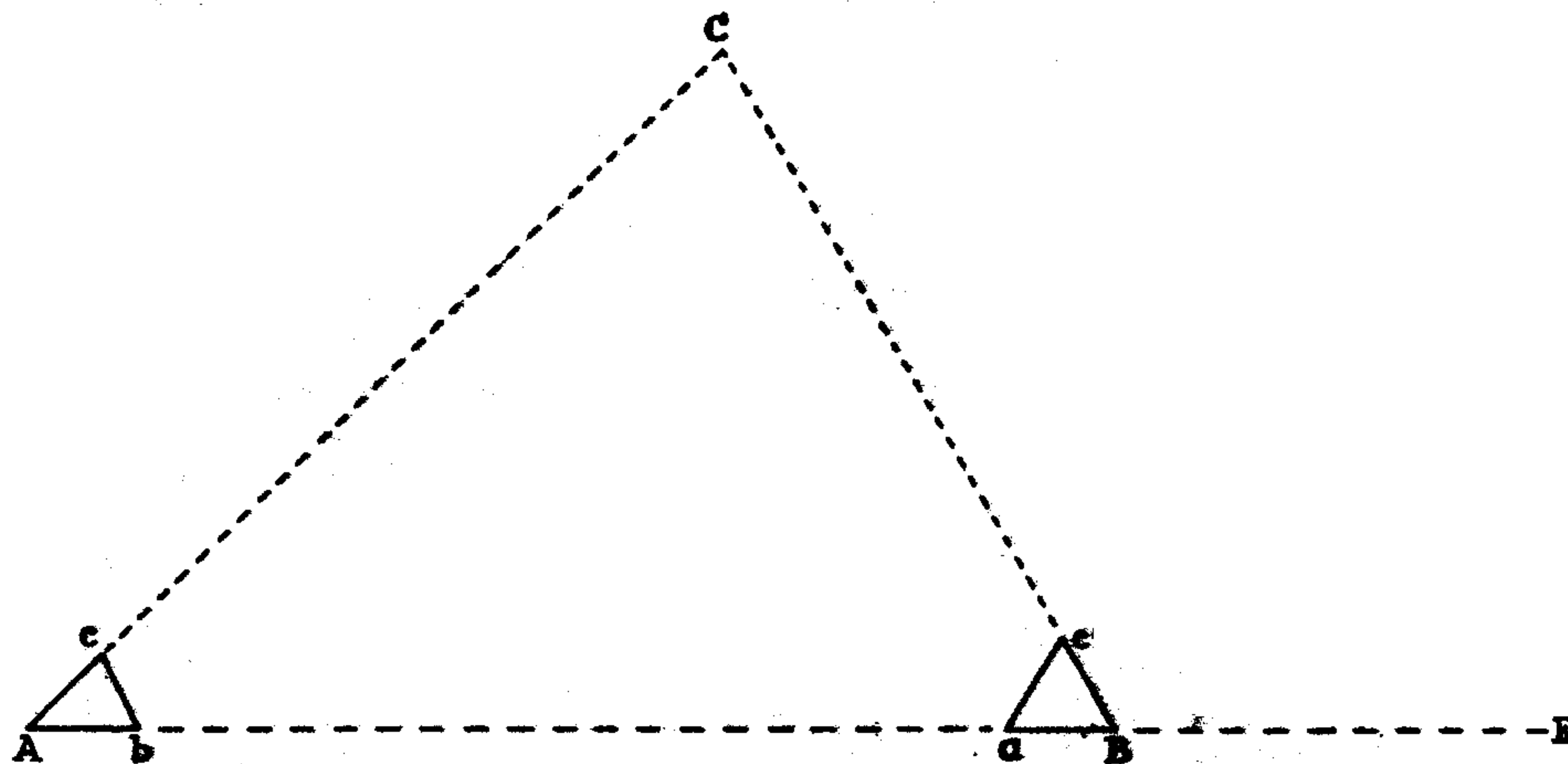
"I have often thought of procuring a really artistically made and coloured globe [elsewhere he suggests one of 9 feet diameter] and once had much correspondence about it. Ruskin wrote a very good letter. It seems to me that one might set to work by making a spherical shell, cutting it up into convenient parts like a puzzle map, and mount the parts that were temporarily wanted to be consulted on a convex table. These could be multiplied by casts, also by electrotype." (British Association, Bradford, Sept. 24, 1873.) The last sentence shows that Galton intended his globe to be a model of the world's *surface*, not a mere map.

³ Seventeen years later Galton proposed at a council meeting of the Royal Geographical Society that the interest on the Murchison Fund be expended this year (? 1872) in procuring specimens of, and a report on, the various styles of cartographic representation now in use both in England and abroad, as regards shading, colours, symbols, and method and cost of production, but not as regards projection, and that a committee should be appointed to arrange particulars.

Galton speaks highly of geographical societies in the help they provide for qualified travellers, and then doubtless comes a touch of his own experience, and

“their moral influence is not to be disregarded, by which they sustain the courage and perseverance of a traveller, whose special tastes find little countenance and sympathy from the associates whom the accidents of birth and neighborhood have made nearest to him¹.”

He kept frequently in his mind the discovery of any means of easing the path of the travelling geographer. Thus we have his “Table for Rough Triangulation without the usual Instruments and without Calculation” of March 1860. This was a simplified form of measuring the distance of an object (breadth of river, etc.) lying off the traveller’s path first suggested with more rigorous calculations by Sir George Everest, formerly Surveyor-General of India². Galton appears to have issued his table on a single leaf, probably for the use of travellers, and it was afterwards incorporated in the *Hints for Travellers* he edited for the Royal Geographical Society. The idea is an exceedingly simple one. We proceed thus :



C is the inaccessible object assumed to be either in the same horizontal plane as our base line AB , or else to be the projection of an object on that plane. We walk ten paces Ac from a peg at A towards C and insert a peg at c . We then walk ten paces towards an accessible object at B and set a peg at b . We pace cb to the nearest quarter pace. Then we walk 100 paces from A to B and in order to maintain a straight line always look at a distant object E behind B ; at a which is 90 paces from A we insert a peg and then do ten more paces to B (peg). Next we step ten paces Bc' from B towards C , and finally pace $c'a$ to the nearest quarter pace. The number of paces in cb and $c'a$ are the two arguments by which we enter horizontally and vertically Galton's Table, and under them we find AC given in paces. If we enter with $c'a$ and cb horizontally and vertically we find BC . If AB

¹ *Loc. cit.* p. 100.

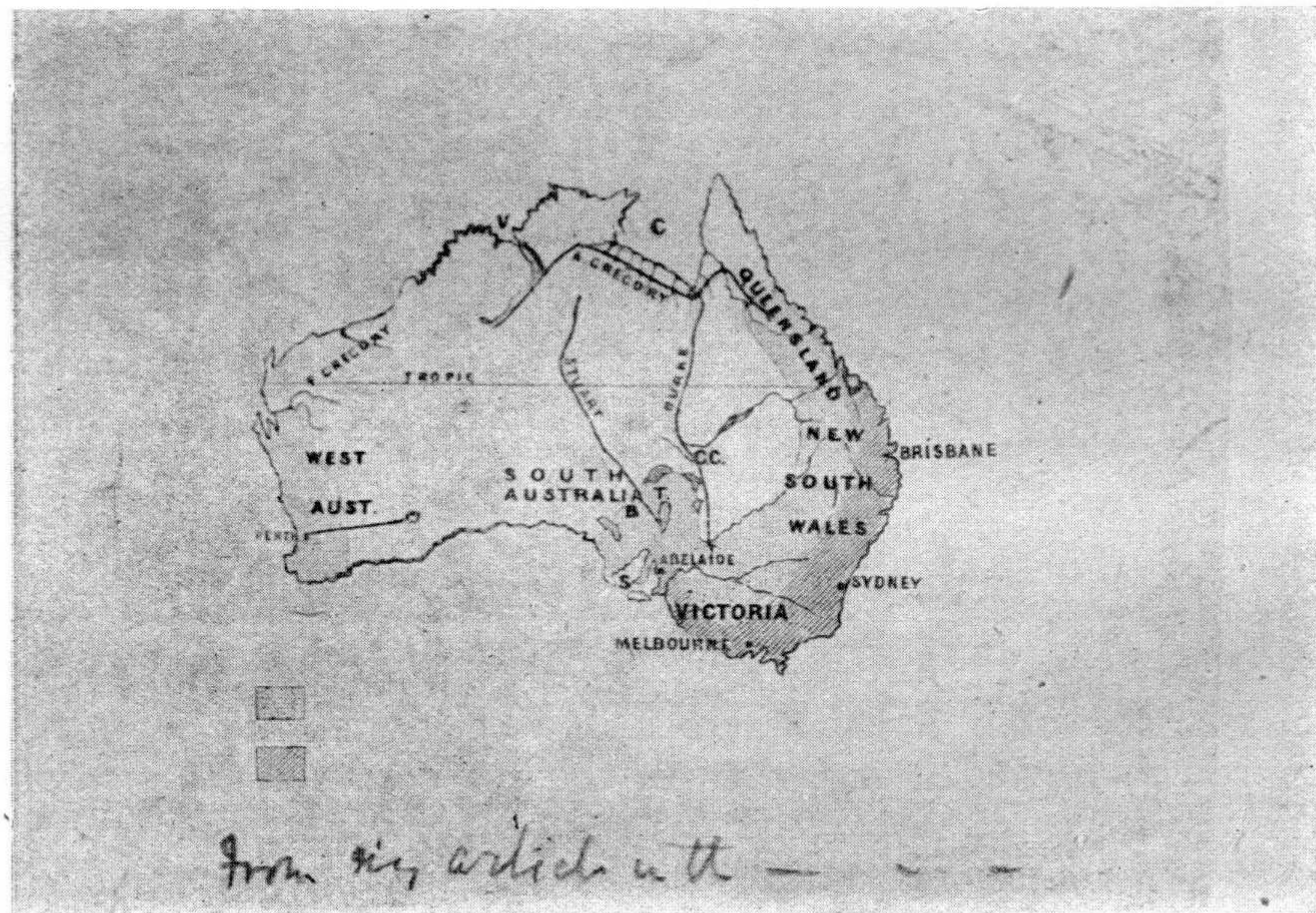
² *Journal of the Royal Geographical Society*, 1860, pp. 321 et seq.

be a north and south line, the angle cAb is the *bearing* of C and this is given in the first vertical column of the table. There is no instrument needful and no calculation. Of course the method is rough, but if care be taken that no angle of the triangle be less than 30° , practically valuable results may be obtained.

Another paper with the same intention of aiding the geographer was that of 1858 on "The Exploration of Arid Countries¹." Galton states his problem as follows:

"I suppose an 'exploring' party, as few in numbers as is consistent with efficiency, to be aided by a 'supporting' party, who may be divided into two or more sections. The duty of this supporting party is to carry provisions, partly to be eaten on the way out, and partly to be 'câched,' or buried in the ground, in order to supply the wants of a homeward journey. After a certain distance from camp had been reached, and the loads of one 'section' of the supporting

¹ *Proc. R. Geographical Society*, Vol. II, pp. 60-77. Galton was much interested in the difficulties of exploring the arid centre of Australia. Among his papers I found a little map of Australia indicating by different shading the settled and squatting districts, and with the desert routes of the Gregories, Stuart and of Burke's cross-continental fatal journey. It was marked in pencil "From my article in the ——" This article, unsigned and not recorded in Galton's



list of published papers, was ultimately run to ground in the *Cornhill* for 1862, pp. 354-64. Its title is "Recent Discoveries in Australia" and it describes the work of the Gregories, Babbage, McDonal, Stuart, Burke and King. It might be read to-day by anyone desiring to get an interest in Australian discovery. One wonders whether Burke's life would have been saved if Galton's system of câches had been fully adopted. One passage may be cited: "It appears hopeless to ascertain the habitable qualities of any district of Australia by seeing it only once. The arid plains after a month's soaking rains are wholly altered. An unexpected fact still remains, it is that wherever a sheep-station is by any means established, the country becomes rapidly improved by its influence. It is a subject for Darwinian speculation. Grazing improves grasses, occupier dams up creeks and deepens water-hole. Perhaps the grasses and bushes flourish through the moisture. Their roots will then form a natural matting that checks evaporation while long fibres of the roots encourage more water to enter deeply into the soil."

party had become exhausted in furnishing meals and câches to the entire expedition, this section would separate from its companions and return home. A second 'section' would subsequently act as the first had done, and afterward a third and even a fourth, according to their original number. Finally the explorers would be left by themselves at some days' journey in advance of the farthest known watering place, with their own loads of provisions untouched, and with other provisions stored in câches, fully sufficient for their return, and in every respect as capable of further exploration as if it was from their own camp, and not from a spot in the heart of the desert, whence they were about to take their departure.

Doubtless the same general idea must often have occurred to other travellers besides myself; but whether it is because the details have been found puzzling and difficult to work out, or because the necessary vessels for carrying water were not to be met with when wanted, no traveller in arid countries has ever availed himself of the great power which this method of exploration affords¹."

Galton starts with a table of the weight of water and food, needed as rations by horse or mule, ox, and man per day, and also the total weights which each can drag or take on its back. The problem is then to determine at what distances each section of the party is to return so as to leave the ultimate exploring party with full weights of rations and full câches for the return journey. It was exactly the sort of problem which delighted Galton; there was a little of mathematics², a little of statistics and considerable amount of ingenuity required, and the whole had a practical bearing. He adopted the *binary* system by which half the remaining party returned at the end of each stage. It would not be fitting here to discuss at greater length Galton's tables and results. He had chiefly in view the then unexplored regions of Australia.

As Secretary of the Royal Geographical Society Galton came into touch with many famous travellers—Burton, Speke, Grant, Stanley, etc. Galton himself drafted the instructions for the Burton-Speke expedition of 1856, which led to the discovery of Tanganyika and the Victoria Nyanza lakes, a discovery made at the painful cost of a quarrel between Burton and Speke. Galton had an all-round admiration for Speke and Grant, and a respect for the eccentric genius of Burton. Of Stanley he thought less favourably as of a man inclined to sacrifice the scientific aspect of geography for what the younger generation would term journalistic 'stunts.' The letters of both Burton and Speke to Galton give evidence of the difficult position of the latter in his relation to the two former as Secretary of the Royal Geographical Society³.

¹ *Loc. cit.* p. 61.

² There is a misprint in Eqn. (3) of p. 65 where in the value for s , the section that turns back first, the numerators of the two fractions should of course be a^{r-1} and a^{r-2} respectively.

³ Galton was first among those who worked for the Speke Obelisk in Kensington Gardens, and he desired above all things that a joint memorial to Speke, Burton, Grant, Baker, Stanley and Livingstone should be arranged near the Speke Obelisk as a reminder to later generations of what our nation has done for African discovery.—We might well add Galton himself to the list.—The time has, perhaps, come now when the smaller, if very human, side of these men might be forgotten under a common monument. Galton wrote a letter to the *Times*, May 25, 1904, advocating such an African memorial to include the names of earlier travellers—Bruce, Mungo Park, Lander, Clapperton and Barth (who was subsidised by England). He suggested a massive block of stone with a map of Africa in bold coloured mosaic on its curved top, even as Africa would appear on a five foot globe. The memorial was to be surrounded by such African trees, shrubs and flowers as will grow in this country. But although Burton and Speke were both dead, the wound was not yet healed and nothing came of Galton's plan.

We can here only afford space for one letter of interest, that from Speke of February 26th, 1863; it indicates the growing feeling between Speke and Burton and at the same time the difficulties that Galton had to encounter.

“ {My reports will be sent from Khar- } GONDOKORO 26 February /63
 { toun as soon as we arrive there. } (to be posted on arrival at [Khartoum¹]
 14° 30' N. Lat. Head winds keep us back.)

27 March.

MY DEAR GALTON

Petherick has shown me a paper of the R. G. Society by which I infer you wrote me a letter suspecting the V. N'yanza to be the source of the Congo or perhaps one of Du Chaillu's rivers because a river was made to run both in and out of it. I fear you did not receive the letter I wrote from Madeira after reading Burton's journal in the Society's volumes, else you could not have supposed so, for in addition to the fact that every Arab knew the 'Kiuiva' river ran out of the Lake and told us they supposed the Lake to be the source of the Jub, every Arab had heard of the vessels on the Nile though Burton tried to hide these matters from the public; I suppose to excuse himself for not visiting the N'yanza. I can only say it is a pity my geographical papers read before the Society were not put into the Society's Journal in preference to Burton's papers, which were not read and therefore not commented on, for that alone has put everybody wrong. Burton's geography was merely a copy of my unfinished original maps, left open until I reached England for further information. Burton wanted me to instruct him, acknowledging that he knew nothing of the topographical features of a country. He could not have written one word unless I had instructed him, but he gave up his lessons too soon, imagined largely on the nucleus I gave him and fell into error accordingly.—You will find all the information you require upon this journey in my reports, so I will now open a new project to you for crossing Africa from East to West following as close as possible upon the line of the Equator; for unless I do it, it will not be done this century. It can be done easily enough on a large scale and with a power of money, but not as I have been travelling at the beck and call of every chief that falls in the way. This is the sum total of my requirements, provided the Govt. is enlightened enough to accept it, which is doubtful we know: Four men of science as captains to 400 negroes, half Crue men from the West Coast, and the other half from Zanzibar, all hands to be furnished with carbines. I should then want a vessel to visit Venice and pick up boats, pass round the West Coast for Crue men, and continue to Zanzibar where the vessel would wait until I commenced the march and then return by the Cape to the mouth of the Congo, where it would await my arrival and convey the 400 men to their respective homes. But this is not all, for I should require another vessel to go up the Nile and form a depôt at Gondokoro. The rest you can imagine. With one word more, I will close my letter and I tell it to you as an overseer to the Society—I firmly believe I should have reached this one year ago and at $\frac{1}{3}$ less expense, if my projects for the journey had been promptly attended to. I asked for leave and money 12 months before starting in order that I might form two Depôts in the interior, but I neither got my leave nor the money until 2 months or so before I started, and therefore could only form one Depôt in advance. That has been the root of my disasters and delay—but 'all's well that ends well,' and there is an end of it, only let the warning be a caution for the future. How I should have rejoiced to receive your letter, but nothing has reached me, not even a letter of advice from Rigby, which announced the departure of some letters and a host of delicacies sent by kind friend Rigby. And now old Galton with Grant's best wishes and my own to yourself and Wife, believe me

Yours ever sincerely H. SPEKE.

P.S. I have sent a map and several papers as I shall not be home in time to contribute to this year's Journal and I fancy it important this should have an early issue."

Let us pity "old Galton" as he read of those 400 men, each to be furnished with a carbine! That great journey, which would have antedated

¹ Deleted.

Stanley's, never came off. In his *Memories* (pp. 201-2) Galton vividly describes the scene at the Bath Meeting of the British Association in 1864, where Burton was to read a paper attacking Speke, and Speke shooting in the neighbourhood had been invited to reply. In the Committee of the Geographical Section (which meets before the open session), at which the President Sir Roderick Murchison, Sir James Alexander, Captain Burton, Galton and others were present, a letter (in the course of a discussion whether the Council of the Association should be requested to bring Speke's services to the notice of the Government) went round the table. It was to announce that Speke had accidentally shot himself dead in drawing his gun after him, while getting over a hedge. Thus ended the life of a man—whom Galton described as “a thorough Briton, conventional, solid and resolute...a fine manly fellow”—in a tragedy, which, one might have hoped—but would have hoped in vain—must stop controversy and bitterness. Burton, Galton tells us, “had many great and endearing qualities with others of which perhaps the most curious was his pleasure in dressing himself, so to speak, in wolf's clothing, in order to give an idea that he was worse than he really was.”

I have not dwelt more at length on this painful controversy as it only indirectly concerns Galton, but it made a very deep and lasting impression on his mind. I am not at all sure it was not the origin of his very strong dislike in later life of all forms of controversy, so that he would let a criticism pass without reply which is not always the most effective manner of fostering the growth of a new and therefore reluctantly accepted branch of science. No reply is too often taken by a thoughtless public to be identical with an admission of error. When the Biometric Laboratory started the series of papers *Questions of the Day and of the Fray* in 1906, Galton expressed his grief at what was not indeed an offensive but in many cases a too long delayed defensive.

Besides preparing plans of travel for various discoverers¹, Galton took, as his manuscript notes show, a large part in the executive work of the Royal Geographical Society. Thus we find about 1858 numerous plans for a meeting-room, the main outline of which he adopted from the old debating-room of the Cambridge Union Society. This, I suppose, had impressed him in Cambridge days as an excellent speaking-chamber, and he wrote to Montagu Butler for a plan and details². Galton further started the movement for increased interest in geography in schools, and it resulted in the Society

¹ Cf. for example the paper “Additional Instrumental Instructions for Mr Consul Petherick” by F. Galton, *Proc. R. Geog. Soc.* Jan. 28, 1861, p. 96, which is a model of what such instructions should be. And again, we may note the “Report on African Explorations,” *Proc. R. Geog. Soc.* May 26, 1862, p. 175, as indicating how Galton kept in touch with African exploration and how fully he carried out his duties of Secretary to the Society. In this paper his condemnation of uncontrolled trade on the White Nile “mostly in the hands of reckless adventurers and lawless crews” is characteristic of the man, who was later greatly revolted by Stanley's proceedings.

² The Secretary informs me that the minutes of the Royal Geographical Society make no reference to these plans, but that the House Committee considered in 1857 proposals for extending the premises. Galton is not named as a member of this committee, but he was probably *ex officio* one of their number, and prepared the plans for their consideration.

offering an annual gold medal to be competed for by public school boys. He afterwards took a considerable part in the agitation which ended in the recognition of geography as an academic study.

Galton was active in many other ways for the cause of geography. In 1861 he was asked to give the Church Missionary Society some information as to Zanzibar as a possible centre of missionary enterprise, having regard to its climate, physical features and the moral and social condition of the people. Galton read a paper to the society on June 1st and it is published in their journal *The Mission Field*¹. In the paper he points out the dominant Arab and Moslem influence which radiated from Zanzibar, not only all along the coast of the mainland but far into the continent, perhaps one-third across. Galton gave his information from manuscript notes of Burton and from photographs of Grant lent by Speke. Galton on the whole spoke well of the Arabs, but ill of the negro natives of the mainland, thus following Burton rather than Speke. He concluded as follows:

“The natives are most assuredly no inquiring race, open to influence, but the very contrary. Again their countries are intersected by commercial routes through which a tide of Moslem ideas is constantly flowing, and could a handful of missionaries, looking at past and present history to guide us in our speculations, be supposed to avail against it? It strikes me, too, as something not quite generous to avail ourselves of the courtesy and the unusual tolerance of a Moslem power to sow seeds of a certain harvest of discord. What we find in Zanzibar is a far-reaching and far-influencing, but not a strong power; anxious to do well, seeking to consolidate itself, amenable to a good English influence, but above all things, the *sine qua non* of its existence is that it should be Moslem. With our very limited missionary agency, it seems to me that we should divert its current to healthier and more hopeful fields than Zanzibar, and that England, so far as she may interfere at all, whether through her representative or by any other agency, should try to effect the following results: To relieve the Sultan, by means of our moral support, from the embarrassment of foreign pressure; to promote safe lines of legitimate and civilising traffic into the far interior of Africa; and to open better communication between Zanzibar and the more civilised world than now exists. This is the schedule of what England is actually doing, and I further believe it is all she ought, for the present, to undertake in Zanzibar².”

This is not the first, nor the last, occasion on which Galton³ emphasised the possibly superior civilising effect of Moslems over Christians on barbarous races. Of course he speaks here of the state of affairs in 1861, before the medical work (India and China) or the craft-school factor (Nigeria) had been added to the purely religious activities of the Christian missionaries. There is a characteristic table of the Zanzibar climate on p. 124, detailing the wind, the rainy, cold and hot seasons and the seasonal healthiness; the paper probably has now fallen much behind the present state of knowledge.

In 1862 Galton took Sir Roderick Murchison's place, who fell ill just before the meeting, as President of the Geographical Section of the British Association. If he gave any opening address, it was certainly a makeshift effort and has not been published. Mrs Galton merely notes that her husband was at Cambridge for the Association⁴. Ten years later, however, 1872, Galton was again President of the same section and gave the cus-

¹ Vol. vi, No. 66, pp. 121-30.

² *Loc. cit.* p. 130.

³ See Vol. I, p. 207.

⁴ Galton recounts an amusing incident of the meeting in his *Memories*, pp. 208-9.

tomary opening address. In this address Galton emphasises the important relations of climate to geography and remarks how human agency can influence both.

“We are beginning to look on our heritage of the earth much as a youth might look upon a large ancestral possession, long allowed to run waste, visited recently by him for the first time, whose boundaries he was learning, and whose capabilities he was beginning to appreciate. There are tracts in Africa, Australia, and at the Poles, not yet accessible to geographers, and wonders may be contained in them; but the region of the absolutely unknown is narrowing, and the career of the explorer, though still brilliant, is inevitably coming to an end. The geographical work of the future is to obtain a truer knowledge of the world. I do not mean by accumulating masses of petty details, which subserve no common end, but by just and clear generalisations. We want to know all that constitutes the individuality, so to speak, of every geographical district, and to define and illustrate it in a way easily to be understood; and we have to use that knowledge to show how the efforts of our human race may best conform to the geographical conditions of the stage on which we live and labour.”

Galton finally turns to maps; he does not refer as in the *Cambridge Essays* to the ultimate goal of the geographer—a map of the world with ordnance map accuracy—but he does return to the idea of combining geographer and artist.

“The facility of multiplying coloured drawings will probably lead to a closer union than heretofore between geography and art. There is no reason now why ‘bird’s-eye views’ of large tracts of country should not be delicately drawn, accurately coloured, and cheaply produced.It is therefore to be hoped, that the art of designing the so-called ‘bird’s-eye views’ may become studied and that real artists should engage in it¹.”

Galton finally concentrates on two practical map proposals. He notes how difficult it is to procure ordnance maps and how much their format hinders their popular use. He suggests that pocket forms of Government maps should be issued, and what is more be sold at every head post-office. We have had to wait many years for anything like the carrying out of Galton’s proposal. Why should we, he asks, not succeed in getting “the beautiful maps for which we, as tax-payers, have paid, but only copies or reductions of them, not cheaper than the original and of very inferior workmanship and accuracy”? Galton’s second proposal was that the Government should be petitioned to issue a five mile to the inch map of the country “to serve as an accurate route-map and to fulfil the demand to which the coarse county maps, which are so largely sold, are a sufficient testimony.” Yet 1872 antedated the cycling and by much more the motoring tourist!²

¹ Galton’s suggestions were not carried very far, but has not the time come for resuscitating two of his ideas by means of air-plane *colour* photography and the use of the stereoscope? So far I have not seen any attempts at air-plane colour photography, nor using air-plane stereoscopic cameras, but such may exist. There seems a real field for experiment in this direction, which might possibly fulfil some of Francis Galton’s fond hopes. Stereoscopic air-plane photography might also have military value. [Since writing these lines I have learnt that the latter aspect of the matter has been considered by the Air Ministry.]

² Galton’s criticism did not wholly fail. The General Committee of the British Association resolved: “That Sir Henry Rawlinson, F. Galton, Admiral Ommanney, J. Hawkshaw, Bramwell, W. De la Rue, Godwin Austin be a Committee (with power to add to their number) for the purpose of representing to the Government the advisability of an issue of the one-inch ordnance maps, printed on strong thin paper, each sheet having a portion of an index map impressed on the outside to show its contents and those of the adjacent sheets and their numbers. Also that

Galton's presidency of Section E at Brighton was marked by the reading of a paper by Stanley concerning his Congo travels. The ex-Emperor Napoleon and the Empress Eugénie were present, and it was feared Stanley might use the occasion in an inappropriate way¹. The meeting passed off, however, with only one interference on the President's part, but with some tension. For those who would realise Galton's strong feelings about Stanley's proceedings the following extract from an article—really by Galton—in the *Edinburgh Review* for January 1878 (pp. 166–91) will be indicative.

“The exploration of Africa has been conducted of late on a new system. The routes of the earlier travellers passed either through parts of the continent where the population is sparse, as in Caffre-land or in the Sahara, or in those where it is organised into large kingdoms, such as lie between Ashanti and Wadai, and which are much too powerful to admit of any traveller forcing his way against the will of their rulers. The older explorers were therefore content to travel with small retinues, conciliating the natives of the larger kingdoms by patient persistence and feeling their way. But of recent years all this has been changed. The progress of discovery has transferred the outposts of knowledge and the starting-points of exploration to places where the population is far more abundant than that which is met with in either the northern or the southern portions of Africa, yet where it is for the most part divided into tribes. Hence modern explorers have found the necessity for travelling with large and strongly armed retinues. This new method has been frequently adopted in the upper basin of the White Nile, which has been the scene of many military expeditions sent by the Egyptian Government to force a way into the Soudan, including that commanded by Sir Samuel Baker. So, in the south, Livingstone's comparatively small band of determined Caffres, placed at his disposal by a chief whose confidence he had gained, enabled him to cross the Continent in the latitude of the Zambesi. Subsequently other travellers like Burton, Speke, Grant and Cameron, starting from Zanzibar, have adopted a similar plan. Their forces were large enough to enable them to pass as they pleased through regions where the tribes were small, they were sufficiently powerful to make larger tribes fear to attack them, and as they invariably adopted a conciliatory policy with the latter, they never came into serious collision with the natives. Mr Stanley has adopted the plan of travelling with an armed retinue on a much larger scale than any of those we have named, and he has certainly carried, by these means, a great expedition successfully through

these maps should be sold in all important towns and, if possible, at the several post-offices, and that Mr F. Galton be the Secretary.” Mr Ayrton, the minister under whose control the Ordnance Survey Office was, saw the deputation but it is not very clear that any definite impression was made on him. On the other hand, Major-General Sir Henry James, Superintendent of the Ordnance Survey Office, wrote a number of appreciative letters, and maps were prepared in accordance with Galton's suggestions. James writes: “As to the difficulty of getting our maps it arises from the fact that we have four agents only for England and Wales instead of at least 250 or one in every tolerably sized town, and these agents are all in London and receive 33½ per cent. instead of 25 per cent. But few and dear as the agents are, they seem to have been selected because they are themselves map-makers and sellers, and sell to the public bad copies of the ordnance maps taken by robbery! This was done against my earnest protest and the Government is losing some £3000 a year by the arrangement, and the public are everywhere dissatisfied.” Henry Fawcett wrote a sympathetic letter and regretted that the matter had not also been brought before the Committee of Section F, of which he was a member.

Galton's index map, however, is now a commonplace of many map publications.

¹ “Mr Stanley had other interests than geography. He was essentially a journalist aiming at producing sensational articles.” *Memories*, p. 207. What vexed Galton peculiarly was that Stanley had made no proper positional observations, and Galton ventured to utter the words “sensational geography.” Stanley in his letters used violent language about the Royal Geog. Society, and about Markham and Galton. He was no doubt excited by the inquiries as to his birth, from which that Society had not and could not entirely disassociate itself. He did not meet that question straightforwardly and fearlessly as he might well have done. (Letters of Stanley and others in *Galtoniana*.)

Africa. Thus he states, 'I led 2,280 men across hostile Unyoro' on an expedition intended to cross the Albert Nyanza. Again, when he leaves Nyangwe on his final expedition down the Lualaba, he starts with a body of 500 fighting men. Thus with a larger military force than hitherto employed, and making a determined use of it, Mr Stanley has conducted a geographical raid across the middle of Africa, which has led him into scenes of bloodshed and slaughter, beginning at the Victoria Nyanza, and not ending until he arrived in the neighbourhood of the Western Coast. [This achievement undoubtedly places Mr Stanley in the foremost rank of African discoverers and ensures to him a hardly-earned and lasting fame¹.] The question will no doubt be hotly discussed how far a private individual, travelling as a newspaper correspondent, has a right to assume such a warlike attitude, and to force his way through native tribes regardless of their rights, whatever those may be. A man who does so acts in defiance of the laws that are supposed to bind private individuals. He assumes sovereign privileges, and punishes with death the natives who oppose his way. He voluntarily puts himself into a position from which there is no escape, except by battle and bloodshed; and it is a question, which we shall not argue here, whether such conduct does not come under the head of filibustering. Nations are above laws, and may and do decide what expeditions they may care to launch, but the assumption of such a right of private individuals is certainly open to abuse, and seems hard to defend. It is impossible to speak of Mr Stanley's journey without noticing this exceptional character of it. At the same time it is not our present object to discuss the morality of his proceedings, but to occupy ourselves with his discoveries, which are unquestionably of the highest geographical importance, and may lead to consequences in comparison with which the death of a few hundred barbarians, ever ready to fight and kill, and many of whom are professed cannibals, will perhaps be regarded as a small matter²."

Galton next proceeds to discuss Stanley's geographical discoveries in relation to those of Schweinfurth and of Barth. Then he turns to the trade products of Africa and its means of transport. Under the latter heading he certainly did not anticipate the modern railway developments nor the rapid increase in mineral and agricultural exports. The general sense of his papers seems to be that the trade is scarcely worth the European's while and is best undertaken by the Arab. But the most valuable and interesting part of the paper which indicates surely the change which had occurred in Galton's outlook—his advance towards anthropology—is the long account he gives of the physical and mental characters of the negro. His judgment is not favourable:

"By picking and choosing out of a multitude of negroes, we could obtain a very decent body of labourers and artizans; but if we took the same number of them just as they came, without any process of selection, their productive power, whether as regards the results of toilsome labour or of manual dexterity, would be very small." (p. 180.)

"Leaving for a moment out of consideration the combative, marauding, cruel and superstitious parts of his nature, and all that is connected with the satisfaction of his grosser bodily needs, his supreme happiness consists in idling and in gossip, in palavers and in petty markets. He has no high aspirations.....He loses more of that which is of value to him in consequence of his labour than he gains by what his labour produces. He has little care for those objects of luxury or for that aesthetic life which men of a more highly endowed race labour hard to attain. His coarse pleasures, vigorous physique, and indolent moods, as compared with those of Europeans, bear some analogy to the corresponding qualities in the African buffalo, long since acclimatised in Italy, as compared with those of the cattle of Europe. Most of us have observed in the

¹ In Galton's own copy these words are enclosed with an ink border and against them is written "an editorial insertion—not mine. F. G." Thus does the smaller intelligence, editing the broader mind, make nonsense of Galton's meaning. If "Barabbas was a publisher," of a surety the railing malefactor was an interpolating editor!

² Were it not for the 'perhaps' we might suspect the last few lines to be another editorial interpolation.

Campagna of Rome the ways of that ferocious, powerful and yet indolent brute. We may have seen him plunged stationary for hours in mud and marsh, in gross contentment under a blazing sun; at other times we may have noticed some outbreak of stupid, stubborn ferocity; at others we may have seen him firmly yoked to the rudest of carts, doing powerful service under the persistent goad of his driver. The buffalo is of value for coarse, heavy and occasional work, being of strong constitution and thriving on the roughest herbage; else he would not be preserved and bred in Italy. But he must be treated in a determined sort of way, by herdsmen who understand his disposition, or no work will be got out of him, and besides that, he is ferocious and sufficiently powerful to do a great deal of mischief." (p. 180.)

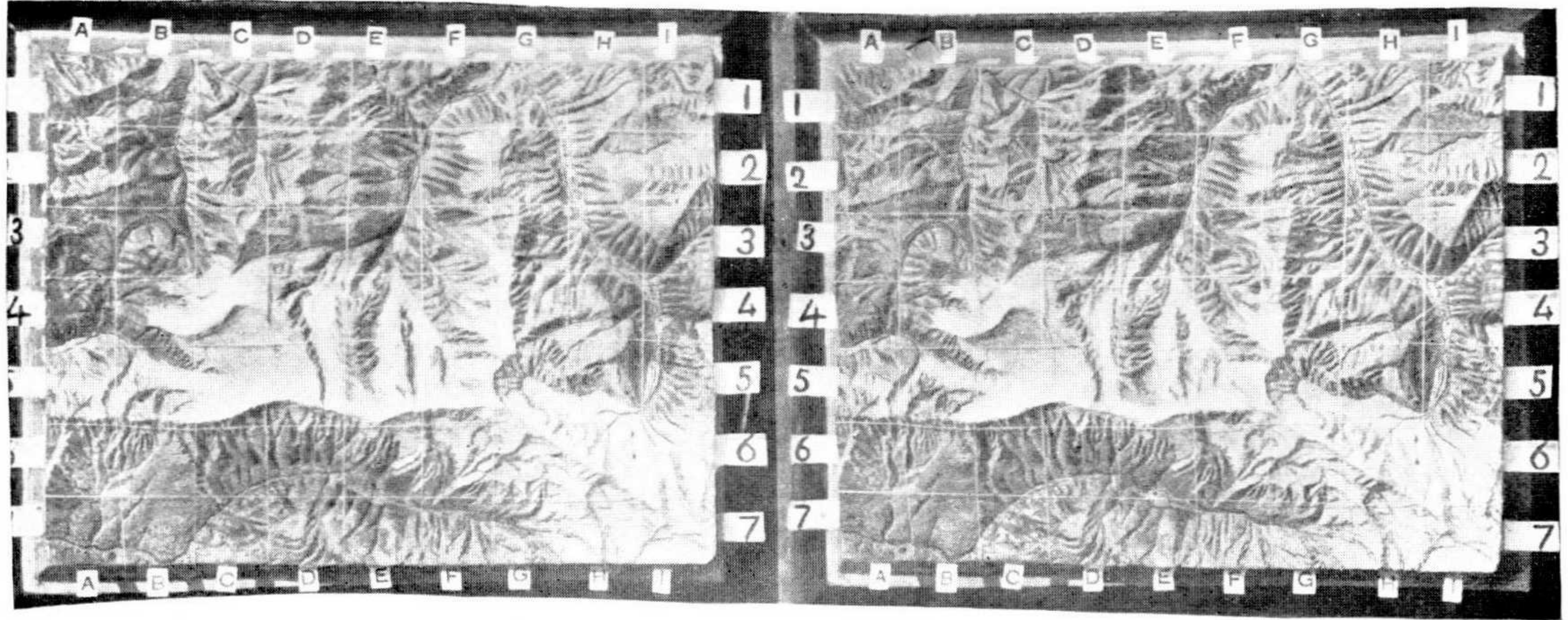
For Galton in 1872, as one race of animals differs from another, so all races of men are not equal. He has started on his recognition of hereditary superiorities. Because the negro belongs to an inferior race, the Arabs, who coalesce with the natives, inter-marry, and do not look upon a converted negro as an inferior, have done far more than Christian missionaries to educate and civilise the negro.

"Of Mohammedanism and Christianity—we do not speak here or elsewhere as to their essential doctrines, but as they are practically conveyed by example and precept to the negro—the former has the advantage in simplicity. It exacts a decorous and cleanly ritual that pervades the daily life, frequent prayers, ablutions and abstinence, reverence towards an awful name, and pilgrimage to a holy shrine, while the combative instincts of the negro's nature are allowed free play in warring against the paganism and idolatry he has learned to loathe and hate. The whole of this code is easily intelligible, and is obviously self-consistent. It is not so with Christianity, as practised by white men and taught by example and precept to the negro. The most prominent of its aggressions against his every-day customs are those against polygamy and slavery. The negro, on referring to the sacred book of the European, to which appeal is made for the truth of all doctrines, finds no edict against either the one or the other, but he reads that the wisest of men had a larger harem than any modern African potentate, and that slaveholding was the established custom in the ancient world. The next most prominent of its doctrines are social equality, submission to injury, disregard of wealth, and the propriety of taking no thought of to-morrow. He, however, finds the practice of the white race, from whom his instructions come, to be exceedingly different from this. He discovers very soon that they absolutely refuse to consider him as their equal; that they are by no means tame under insult, but the very reverse of it; that the chief aim of their lives is to acquire wealth; and that one of the most despised characteristics among them is that of heedlessness and want of thrift. Far be it from us to say that the modern practice in these matters may not be justified, but it appears to require more subtlety of reasoning than the negro can comprehend, or, perhaps, even than the missionary can command, to show their conformity with Bible teaching." (p. 187.)

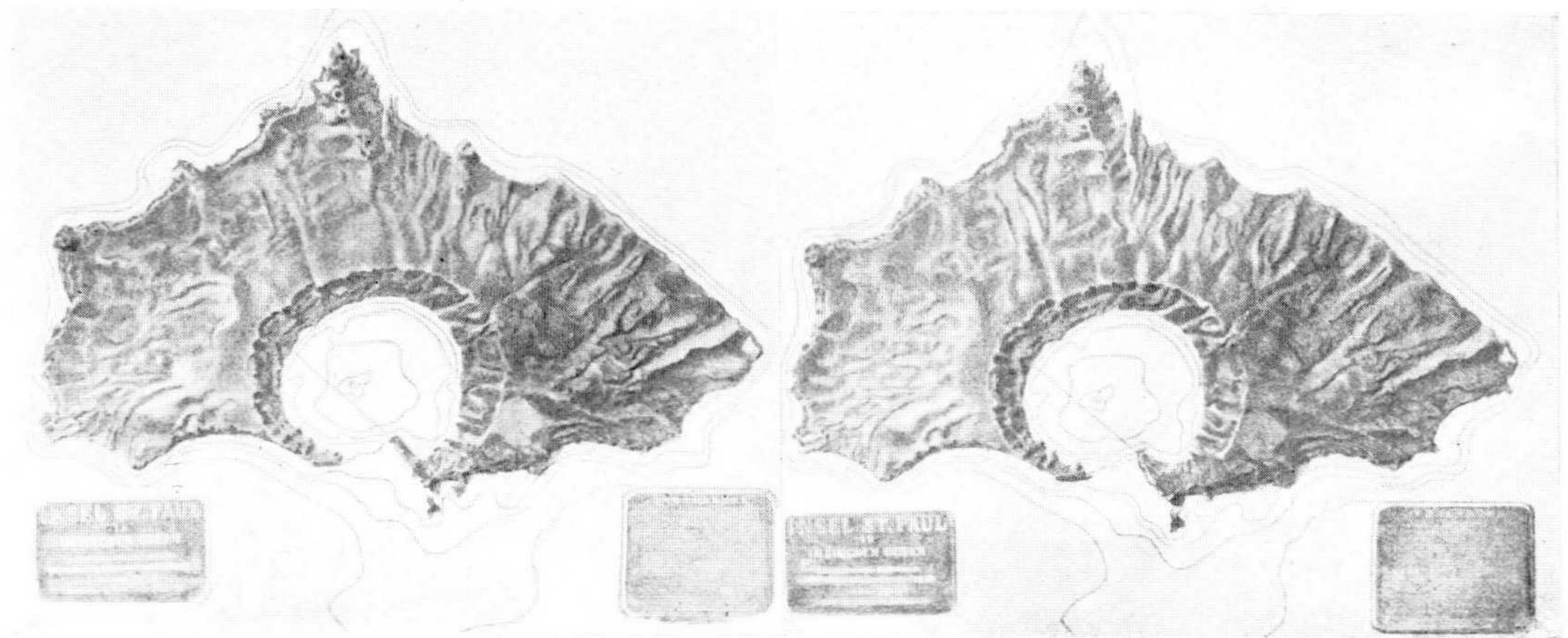
Galton's anthropological sense was rapidly developing; he was firmly grasping the relativity of religions, how they have no absolute validity, but the suitability of any creed depends on the stage of the mental and even the physical development of a given race. Shortly, a religion must be in harmony with the habits and culture of a given people at a given time, or it will fail to fulfil its purpose—which, from the anthropological side, is to strengthen and to stabilise the social purposes and gregarious instincts of a definite group of men. As Galton realised, Christianity has built up no negro kingdoms, but Mohammedanism has done so, and the negro converts erect mosques, maintain religious services, and conduct their schools without external support.

That Galton was not wholly content to leave Africa to Negro and Arab is evidenced by his letter to the *Times* of June 6, 1873. In that letter he recognised that much of Africa cannot be occupied by the European, that

PLATE IV



Ortler Spitze and Stelvio Pass.



Island of St Paul.

Stereoscopic views of Geographical Models (should be examined with a stereoscopic lens-doublet.)

“average negroes possess too little intellect, self-reliance and self-control to make it possible for them to sustain the burden of any respectable form of civilisation without a large measure of external guidance and support. The Chinaman is a being of another kind, who is endowed with a remarkable aptitude for a high material civilisation. He is seen to the least advantage in his own country, where a temporary dark age still prevails, which has not sapped the genius of the race, though it has stunted the development of each member of it, by the rigid enforcement of an effete system of classical education, which treats originality as a social crime¹.....The natural capacity of the Chinaman shows itself by the success with which, notwithstanding his timidity, he competes with strangers, wherever he may reside. The Chinese emigrants possess an extraordinary instinct for political and social organisation; they contrive to establish for themselves a police and internal government, and they give no trouble to their rulers so long as they are left to manage these matters for themselves.”

“The history of the world tells a tale of the continual displacement of populations, each by a worthier successor, and humanity gains thereby. We ourselves are no descendants of the aborigines of Britain, and our colonists were invaders of the regions they now occupy as their lawful home. But the countries into which the Anglo-Saxon race can be transfused are restricted to those where the climate is temperate. The tropics are not for us to inhabit permanently; the greater part of Africa is the heritage of a people differently constituted to ourselves. On that continent, as elsewhere, one population continually drives out another. We note how Arab, Tuarick, Fellatah, Negroes of uncounted varieties, Caffre and Hottentot surge and reel to and fro in the struggle for existence. It is into this free fight among all present that I wish to see a new competitor introduced—namely the Chinaman. The gain would be immense to the whole civilised world if he were to outbreed and finally displace the negro, as completely as the latter has displaced the aborigines of the West Indies. The magnitude of the gain may be partly estimated by making the converse supposition—namely the loss that would ensue if China were somehow to be depopulated and restocked by negroes.”

Whatever opinion we may hold of Galton's views on the Chinaman, there is no doubt that this passage marks not only his full acceptance of the doctrine of the survival of the fitter race as applied to man, but further his opinion that civilised man could himself directly expedite the processes of evolution.

A few further memoirs having a bearing on geographical or allied topics may be noted here. We have already referred to his views on maps. In 1865 the idea occurred to Galton that, as maps so conspicuously fail to give us the leading features of a mountainous country and are indeed so incapable of representing crags and cliffs successfully, a stereoscopic photograph of a model would be of extreme value². Indeed a coloured model on this plan with reproduction by colour photography might go a long way to satisfy Galton's craving for something more illustrative of the floral and geological environment than an ordinary map can provide. He suggests what might be done in this way by photography of the models of the English Lakes at Keswick, of the Pyrenees at Luchon, and of the Alps at Berne, Zurich, Lucerne and Geneva. With the assistance of Mr R. Cameron Galton he was able to obtain and exhibit stereoscopic photographs of the following models:

- (1) Island of St Paul in the Indian Ocean³, from an Austrian bronze model.

¹ Was this sentence a thrust at another race, and was Galton thinking of his own bitter experience? See Vol. I, pp. 12, 142.

² “On Stereoscopic Maps taken from Models of Mountainous Countries,” *R. Geog. Soc. Journal*, 1865, pp. 99–106.

³ Midway on Mercator's chart between Melbourne and Cape Town.

- (2) The Ortler group of mountains, from an Austrian model.
- (3) Mount Blanc district, from Bauerkeller's relief map.
- (4) Cape Town and Table Mountain, from a coloured model.
- (5) Abyssinia, from a rude model.
- (6) The Isle of Wight, from a rude model.

The paper itself is accompanied only by a photograph of (1)¹, somewhat confusing as it illustrates also the proposal of Galton to build up large maps in stereoscopic sections.

The Galton Laboratory possesses stereoscopic slides of (1) giving the whole island, and of (2)—(6) inclusive, and also of a seventh slide—part of the Ile de Porquerolles in the Mediterranean off Toulon. Our photographs have faded in the course of nearly sixty years but they show still with extraordinary effect the success of Galton's idea. The Stelvio stands out in a way that no map can compete with, and hardly a bird's-eye view from the Spitz itself could give such a good conception of the 'lie of the land.' It is a grievous pity that the stereoscopic idea of map-models has been forgotten, and we might hope for its resuscitation in association with the air-plane as already suggested. We provide in the accompanying plate copies of the faded photographs of (1) and (2) which nevertheless will suffice—if the reader be lucky enough to possess a pair of stereoscopic lenses—to justify this statement.

Another paper of this same year is entitled: "Spectacles for Divers and the Vision of Amphibious Animals." In this paper Galton states that if water is *in contact* with the human eye² a double convex lens of flint glass, each of whose surfaces has a radius of 0.48 inch, will correct the concave water-lens. It will require to be supplemented by another of moderate power according to the convexity of the individual eye and refractive power of the different kinds of flint glass. Galton found, however, that even with a lens of this kind under water the eye had not much power of accommodating itself to different distances, and his own distinct vision was restricted to a range of about eight feet. He considered, however, the glasses he used only provisional³. He thought such spectacles might be useful to divers in pearl and sponge fisheries, or to sailors examining the bottoms of ships. The paper suggests that amphibious animals must have a power of adjusting their sight, i.e. seals, otters, diving birds, etc., but does not enter into the *modus operandi*. Here again as in the case of stereoscopic maps I think an interesting question has failed to be carried further.

As late as 1881 Galton still maintained some interest in geographical research, but his main work was directed into other and more congenial channels. In the *British Association Report*, 1881⁴, there is a brief comparison by Galton of the equipment of exploring expeditions in 1830 and 1880. He notes the progress that has been made in certain instruments:

¹ Search at the Royal Geographical Society having failed to discover the originals, a further hunt among the negatives of the *Galtoniana* has brought to light the originals—too late for reproduction here.

² *B. A. Report*, Vol. xxxv, 1865 (Sect.), pp. 10–11, not as when the diving helmet is used.

³ Still extant in the *Galtoniana*.

⁴ pp. 738–40.

e.g. mercurial horizons, thermometers and barometers, the binocular glasses, steel and stylographic pens; the progress in clothing, flannel, peacoats and macintoshes; progress in preserved foods; progress in the *personnel*, the educated classes are physically better developed, which Galton attributes to their leading healthier lives, owing to the heavy eating and drinking having ceased, to the better ventilated bedrooms and proper holidays. Lastly he notes the greater ease and quickness with which an explorer can reach the starting-point of his wanderings. The idea suggested in the last sentence probably led Galton to what, I think, was his last contribution to geographical science. In the same year¹ he constructed an "isochronic passage chart for travellers." It consists of a map of the world on Mercator's projection indicating by five colours in two shades the number of days required to reach from London all parts of the world. The map might easily be a little more detailed as the unit of time ten days is rather large, extending from London to Jerusalem, Peru, and Hammerfest, but not to New York. A similar map made to-day would be of much interest, especially in view of the great development in forty years of trans-continental railways and fast steamships. Galton took, as his authorities, time tables of steamship companies and railways, with public and private post-office information.

It cannot be denied by those who study Galton's memoirs on geography that they mark a continuous development. He remains to the end keen on the mechanical 'dodges' and graphical artifices which had delighted the boy at Atwood's² and the youth at Cambridge³; but travel for novelty soon became for him travel for a knowledge of physical environment; in this stage Galton was a pure geographer, but then very rapidly the important part of this environment became for him its relation to man and Galton, without realising the full meaning of the change, had passed from the geographer to the anthropologist⁴. Even by the 'seventies' geography had become a secondary study.

The last of Galton's writings that touches on exploration was his graceful preface to W. E. Oswell's *William Cotton Oswell, Hunter and Explorer* of 1900. In this Galton claims justice for Oswell as the first explorer to reach Lake Ngami; Livingstone simply went with Oswell and Murray as a guest, but Livingstone's later fame and Oswell's reticence led to a retrospective credit being given to the former for this first great journey.

C. CLIMATE

Parallel with Galton's geographical research we find a correlated study—that of meteorology. The services he rendered to this science have been only occasionally recognised at their full value, and much that he has suggested would be worthy of reconsideration and adaptation to the modern state of meteorological knowledge.

¹ "On the Construction of Isochronic Passage Charts," *British Association Report*, 1881, pp. 740-41; *Roy. Geog. Soc. Proc.* 1881, pp. 57-58. ² Vol. 1, p. 77. ³ Vol. 1, p. 148.

⁴ A very valuable letter of Galton's, advocating the adequate representation of Geography and Anthropology in the 'Proposed Imperial Institutes,' will be found in the *Times*, October 6, 1886 (p. 8).

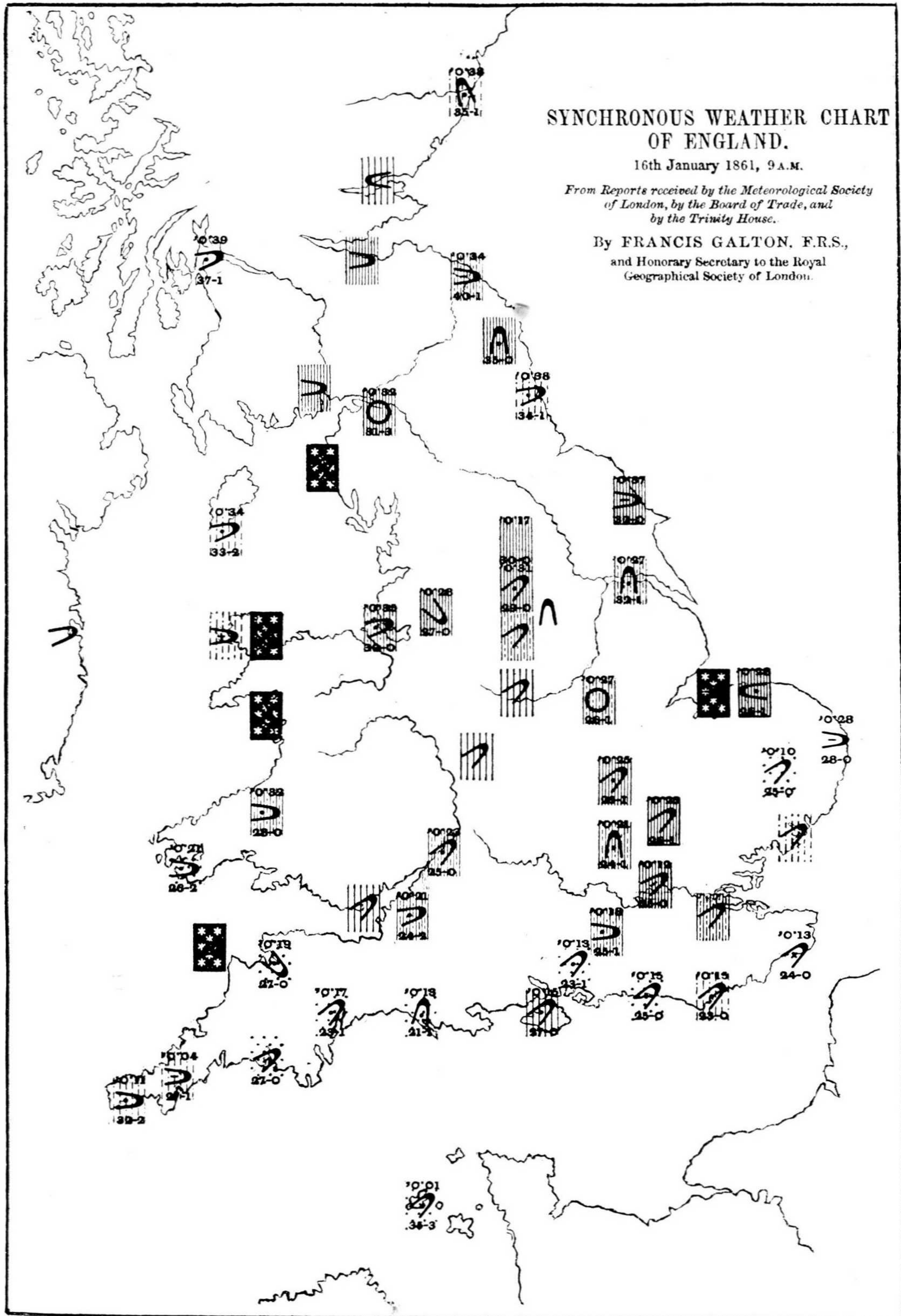
Galton's first considerations on climate sprang directly from his geographical work and were closely associated with the relation of the health of the explorer to the climate¹. Thus we have already referred to his little table of climate in Zanzibar in the lecture of 1861. Two years later he prepared a table giving the "Climate of the countries bordering Lake Nyanza, 1861-2." He published it in the *Royal Geographical Society Proceedings*, Vol. VII, 1863 (pp. 225-8), in a paper entitled "On the Climate of Lake Nyanza": it gives with the exception of the middle fortnight of November meteorological details for every 'week' of every month². The mean temperature for the week, the maximum and minimum and the extreme ranges are provided. The rainfall in inches is given where available, the number of rainy days per week, the number of days per month of rain sufficient to be measured, and the total number of days per month of rain and slight showers, also the prevalent wind for each month. The whole of the material was due to Speke and Grant, but it obviously required much 'dressing,' i.e. smoothing and interpolation, etc. It was based on observations taken at Karagwè (5100 ft.), Uganda (3400 ft.), Unyoro (3200 ft.) and in a camp 3400 ft. above sea-level, so that there is considerable heterogeneity in the data. Speke's original log is among the *Galtoniana*.

The tables thus formed led Galton to consider the possibility of maps combining at a single glance much meteorological data. This occupied his mind largely in 1861-2, and there is no doubt that Galton was the first to publish meteorological maps of Europe, possibly of any country at all. He induced his friend W. Spottiswoode, the head of the great printing firm, to cast movable types which were used in Galton's first maps. These represented by shaded rectangles Rain, Snow, Dull and Overcast, Overcast, Mostly clouded, Half-clouded, A few clouds, Clear blue sky; the direction and force of the wind were given by another series of symbols, and finally the height of the barometer and the temperature—ordinary and wet bulb—were printed in figures. Thus a rectangle 8.5 mm. high by 5.5 mm. broad contained the information as to rain and cloudiness, intensity and direction of wind, state of barometer and thermometers at a given meteorological station, and these rectangles were placed centrally to each station on a map of the stations at which observations had been made. Galton's first map³ is

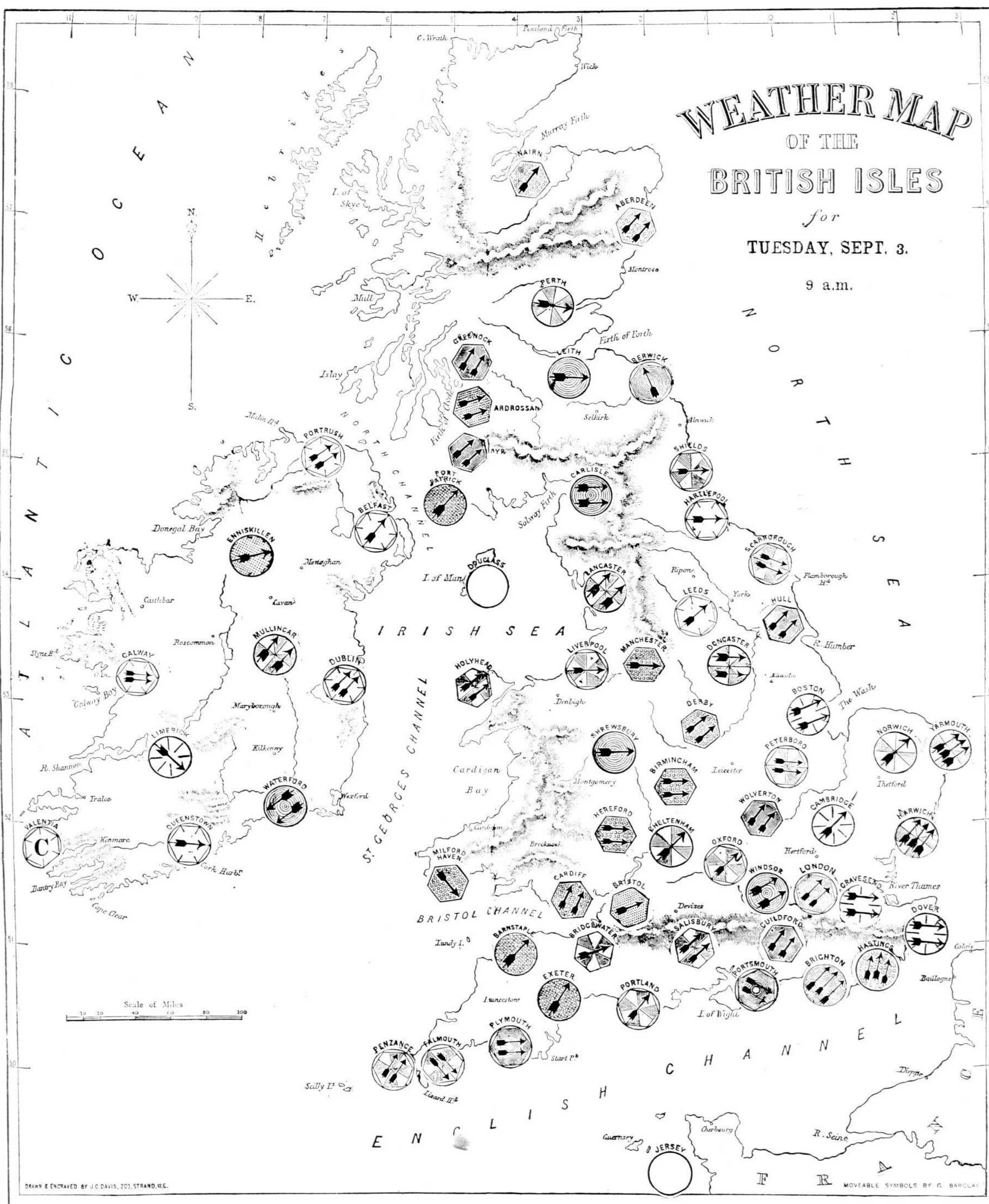
¹ The effect of climate on the traveller had been brought home to Galton very emphatically by his own experience of the after-effects of his travels in Syria and tropical Africa.

² 1st to 7th, 8th to 15th, 16th to 23rd, 24th to end. Thus the first 'week' was 7, the second and third 'weeks' each 8, and the fourth 'week' 7 or 8, or in the case of February only 5 days.

³ Among Galton's papers is another "Weather Map of the British Isles for Tuesday, Sept. 3, 9 a.m." No year is stated, but I should think it was more probably Tuesday, Sept. 3, 1861, than Tuesday, Sept. 3, 1867. In this map five conditions of wind intensity, five conditions of sky (clear, detached cloud, overcast or fog, showers, rain) and three pressure conditions (barometer falling, stationary, rising) are indicated by no less than 75 circular 'stamps.' The direction of the wind is given by the direction of the arrows which measure wind intensity and the circular stamps are rotated to give this direction. A map is printed with the names of the 60 to 70 recording stations, and underneath these names the appropriate stamp is affixed with the right orientation. 25 copies of these attachable stamps for the case of rising barometer



One of Galton's earliest synchronous weather maps, issued with his circular concerning European weather in 1861: see our p. 38.



EXPLANATION OF THE SYMBOLS

The Outlines signify the indications of the **Barometer** being respectively hexagonal, circular or composite as the Mercury at the time is falling, stationary or rising

The Arrows show the force & direction of the **Wind**

Calm Breeze Brisk Gale Hurricane

N.B. The arrows fly with the wind

The surface indications denote the **Weather**

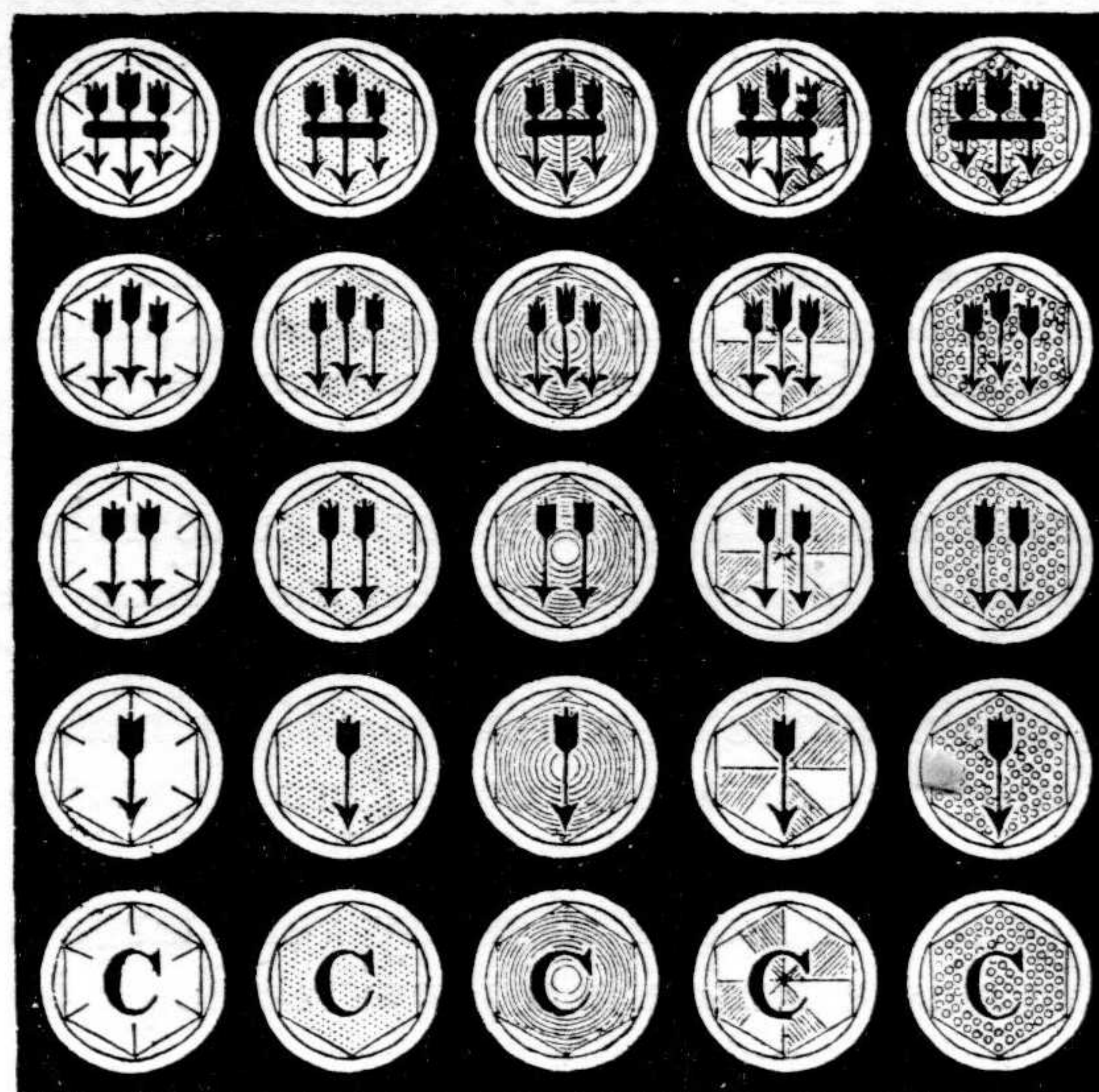
Clear Detached Cloud Overcast or Fog Showers Rain

One of Galton's earliest synchronous weather maps, probably for Sept. 3, 1861, showing the use of his circular stamps to indicate direction of wind and nature of barometric change.

printed only in two colours, red outline for England and black shading for rain and cloudiness. It is entitled: "English Weather Data, Feb. 9, 1861, 9 h. a.m.," and is part of a circular issued from 42 Rutland Gate and dated June 12, 1861. "The accompanying sheet has been printed as an experiment, by means of movable types which I have had cast for meteorological purposes." To save confusion of figures, barometric heights were not inserted on the map, but lines of equal pressure having been deduced, the places where the isobars of each $\frac{1}{10}$ of an inch cut the right- and left-hand borders of the map were marked, and a straight line joining any pair of corresponding figures was taken to be approximately the corresponding isobar. These isobars were not given on the map¹.

In July 1861 Galton issued another circular, this time addressed to European meteorologists and printed in English, French and German². He appeals to them to provide synchronous meteorological data for a series of aërial charts of Northern Europe (latitudes, $42^{\circ} 25'$ on the south, including all France and Perugia, to 61° on the north, including Shetland, Bergen and Christiania; from the westernmost limit of the British Isles to Königsberg, Warsaw and Budapest). The data were to be for the whole month of

have survived. When the proper stamps have been attached the map is ready for photography or engraving. I do not know why Galton replaced these circular stamps by the oblong blocks of his later maps, possibly because the oblongs were easier to set up in a press and actually print on to the map. This map looks more graceful than those of the circulars, but contains somewhat less information. The two maps can be compared in the accompanying plates.



Specimens of Galton's circular stamps for attaching to maps and so forming synchronous weather charts. See footnote 3, p. 36.

¹ This circular almost in the same words appears as an article entitled "Meteorological Charts" in the *Philosophical Magazine*, Vol. xxii, 1861, pp. 34-5.

² This is, I believe, Galton's first appeal by circular for the filling in of schedules, a practice considerably developed by him later.

December 1861, and synchronously at 9 a.m., 3 p.m. and 9 p.m. for each day. The specimen map sent with the chart is a considerable improvement on that of the June circular. It is entitled: "*Synchronous Weather Chart of England, 16th January 9 A.M.* From Reports received by the Meteorological Society of London, by the Board of Trade and by the Trinity House." About 50 stations were used. It is printed in three colours—the outline map in green, the rain and cloudiness rectangles in brick red, and the wind symbols and figures for barometer and thermometers in black. The circular itself gives the most minute directions for observations, and even rules as to postal dispatch. Finally also a blank schedule was sent on which the desired data would be written in together with printed tables for reducing Centigrade and Réaumur to Fahrenheit, and millimetres, Paris lines and Russian lines to English inches for the barometer. As a return for assistance Galton promised a copy of his publication to contributors.

We reproduce here Galton's map of 1861 in a single colour and reduced to the size of our page, and also one of the *Meteorographica* maps of 1863.

The materials obtained by Galton's circular were somewhat disappointing, yet Galton proceeded to reduce them; his book or better atlas: *Meteorographica or Methods of Mapping the Weather; illustrated by upwards of 600 printed and lithographed diagrams referring to the Weather of a large part of Europe during the month of December 1861*, was published by Macmillan and printed by Eyre and Spottiswoode. In the text of this work Galton insists not only on the need of tabulating observations, but on representing the results in map form if general laws are to be drawn from them. Maps are as essential to meteorology as to geography. I believe Galton was the first or among the first to insist on this almost obvious truth. But, alas!—

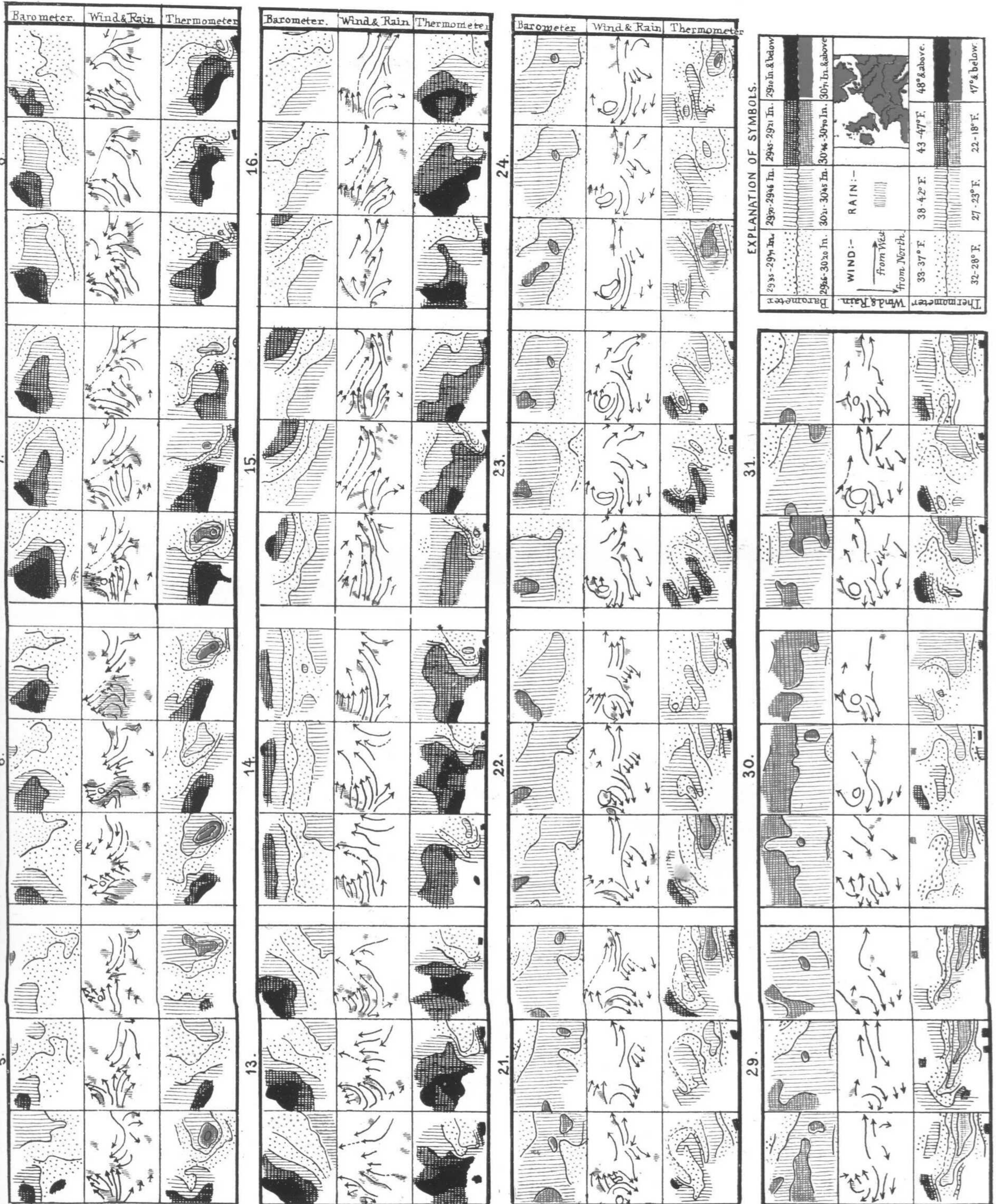
"A scientific study of the weather on a worthy scale seems to me an impossibility at the present time from want of accessible data. We need meteorographical representations of large areas, as facts to reason upon, as urgently as experimental data are required by students of physical philosophy."

Galton draws attention to the fact that meteorologists are strangely behindhand in the practice of combining the materials they possess. While there are more than 300 skilled observers recording thrice daily with excellent instruments, the practice of combining their material is absent. "No means exist of obtaining access to any considerable portion of these observations without great cost, delay and uncertainty¹." For the most valuable results in meteorology it is needful to study very large areas, or indeed the world as a whole. No single nation can provide adequate data spread over a wide enough area for valid conclusions.

"The labour of a meteorologist who studies the changes of the weather is enormous before he can get his materials in hand and arrive at the starting-point of his investigations. In the

¹ Thirty or more years later the biographer found the same difficulty still in existence, when correlating barometric heights across the Atlantic, eastward from Hammerfest to Cape Town, westward from Halifax to the Falklands; the required data existed in manuscript, but were very costly to get copied.

AFTERNOON AND EVENING ON EACH DAY DURING DECEMBER, 1861



A series of weather maps from the *Meteorographica*.

ordinary course he has to apply, with doubtful chance of success, to upwards of 10 Meteorological Institutes in Britain and Europe, for the favour of access to the original documents received by them, and to fully 30 individuals besides. He has next to procure copies, then to reduce the barometer and thermometer readings to a common measure, and finally to protract on a map. I feel that all this dry, laborious, and costly work, which has to be undergone independently by every real student before he can venture a step into scientific work, is precisely that which should be undertaken by Institutes established for the advance of Meteorology." (p. 3, col. i.)

Galton's own list of failures is considerable:

"There was no central Institute in Switzerland.....neither was there any recognised Institute in Denmark or Norway. Whether by accident or misunderstanding, several promised communications from Denmark have never reached me, to my great regret, for its weather was closely linked with our own. From Sweden I could obtain nothing, from France next to nothing¹, from Bavaria only the valuable observations made at Munich. From Italy I had considerable hopes held out to me, but little fruit. The interior of Ireland is wretchedly represented, and would have presented a gap, like France, were it not for two eminent astronomers and some chance assistance besides." (p. 4, col. ii.)

The bulk of Galton's data came from Belgium (with the aid of Quetelet), Holland (with the help of Buys Ballot), Austria (from Kreil) and Berlin (from Dove). To the three former Galton tenders his special thanks. Then comes Galton's excuse for his publication of a work based on admittedly inadequate data:

"Entertaining the views I have expressed on the necessity of meteorological charts and maps, and feeling confident that no representation of what *might* be done would influence meteorologists to execute what I have described, so strongly as a practical proof that it could be done, I determined to make a trial by myself, and to chart the entire area of Europe, so far as meteorological stations extend, during one entire month, and I now publish my results." (p. 3, col. ii.)

A most important discovery was made by Galton as soon as he had begun plotting his wind and pressure charts. While Dove had recognised that centres of low pressure in the northern hemisphere were associated with counter-clockwise directions of the wind round a centre of calms, and termed this system a cyclone, Galton noted that centres of high pressure are associated with clockwise directions of the wind round a centre of calms. Galton termed this system an *anticyclone*, and the name rapidly came into general use, and is very familiar now although few who use it remember that Galton first noticed the system and coined the name².

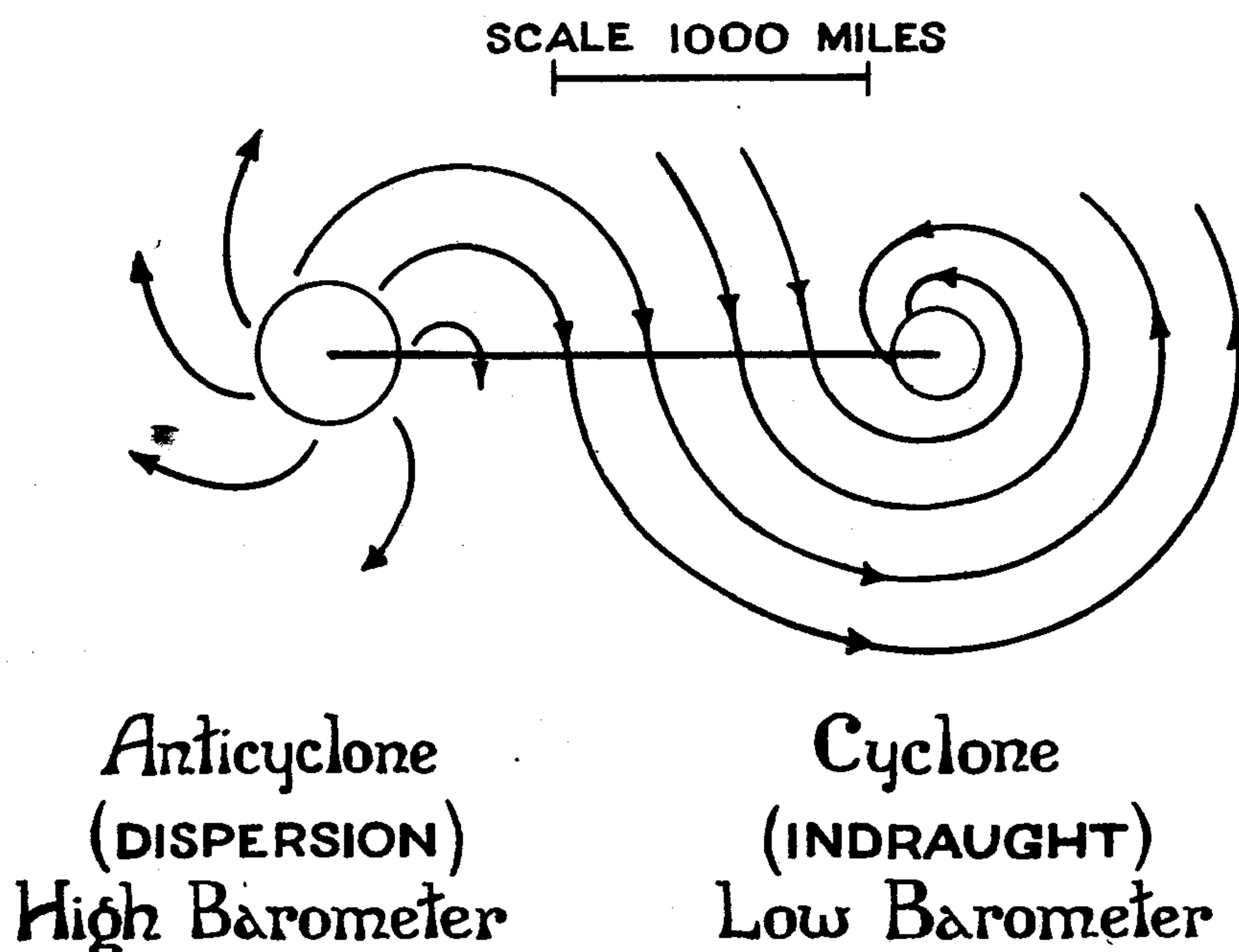
When one studies Galton's tiny charts of pressure and wind for the thirty-one days of December 1861, each chart extending over the whole of Central Europe, and thinks of the paucity of his data, one cannot but wonder at the inspiration which led him to his conclusions. Luckily December 1861 was a month of contrasts, the first half of the month marked a series of cyclones—

¹ Appeal to France for scientific information is even after the war nearly always in vain; letters remain unanswered, and presents of memoirs unacknowledged. From both Germany and Austria, even at the present day, one is fairly certain of a full and courteous reply, and almost any German University Library will still lend a book inaccessible in this country. Narrow nationalism in science is a crime against our common humanity.

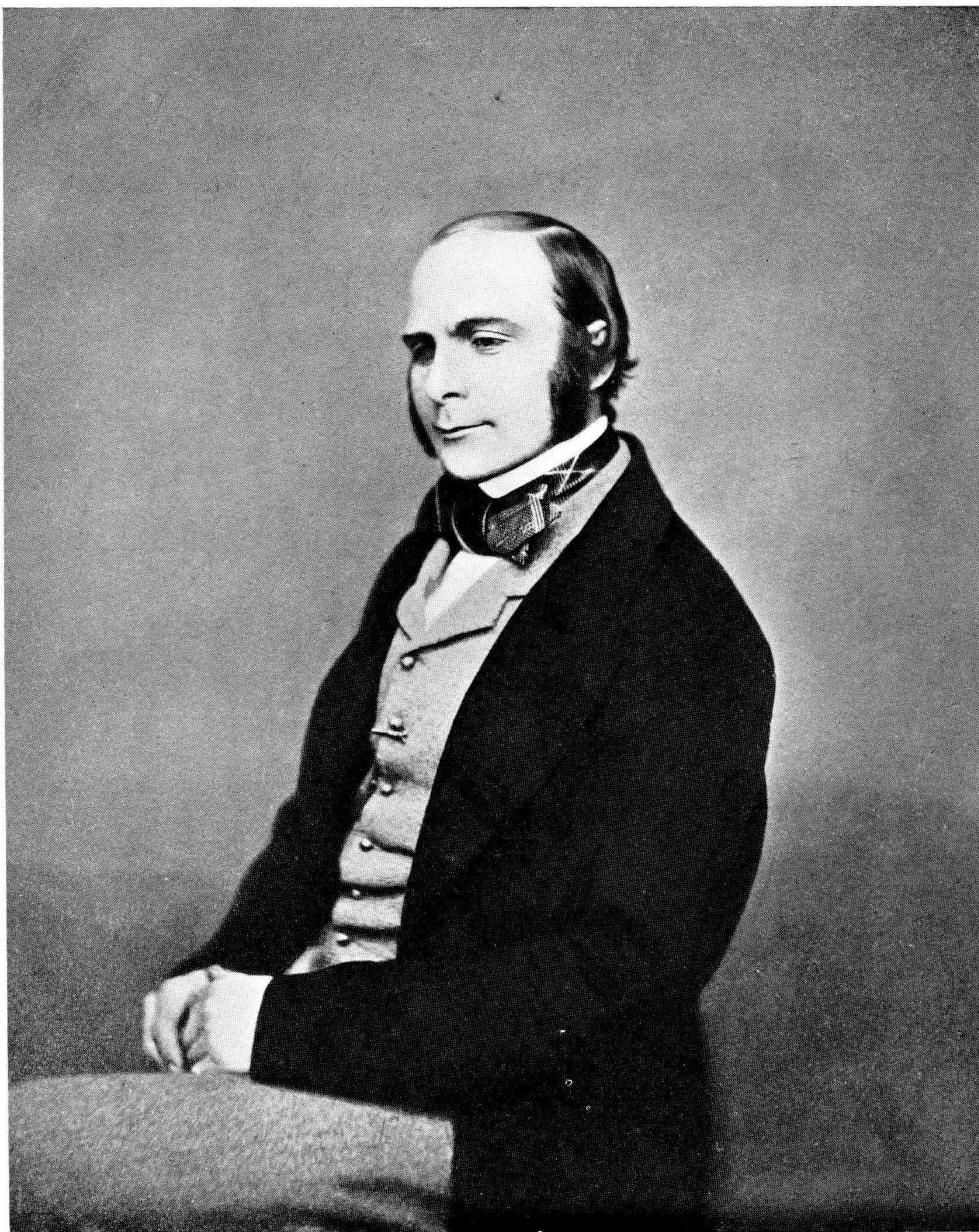
² "A Development of the Theory of Cyclones." Received Dec. 25, 1862. *Royal Society Proceedings*, Vol. XII, 1863, pp. 385-6.

the black areas of low pressure on the barometer charts corresponding to a whole series of counter-clockwise running arrows on the wind charts; and the second half of the month marked a series of anticyclones—the red areas of high pressure on the barometric charts corresponding to a whole series of clockwise running arrows on the wind charts. About the middle of the month we have the transition from black to red areas on the barometric charts, and here sure enough are two systems of arrows on the wind charts one counter-clockwise and one clockwise. *But* it is very clear that the broad band from the Skelligs to Königsberg, west and east, and from Siena to Christiania, south and north, was largely inadequate to exhibit the ‘cores’ of a cyclone and

Galton's Early Idea of Anticyclone and Cyclone



anticyclone on the same chart. The cores of one or other or even of both lay outside the large area for which Galton was plotting simultaneous observations. As I have already remarked, a single continent is scarcely sufficient for the study of meteorological observations. Such is one of the main lessons of the *Meteorographica*, and one doubts if it had been realised before that publication. Yet Galton recognised that if an observer in the northern hemisphere supposed himself standing at the core of an anticyclone—i.e. a centre of high pressure—and facing towards the core of a cyclone—i.e. a centre of low pressure—the winds would pass from his left to his right hand. If we term the line of his sight a bi-cyclonic line, Galton in his Royal Society paper of December 1862



Francis Galton, aged 38, from a photograph of 1860.

supposed that the wind would cross this bi-cyclonic line at an angle of 45° . In his *Meteorographica* he had modified this statement. He writes:

“Many meteorologists will refer with eagerness to these wind charts, to see how far they may confirm or oppose the theory of cyclones. I deduce from them.....that they testify to the existence, not only of cyclones, but of what I ventured to call ‘anticyclones.’ If the lines of wind currents, in the black and red lithographs, are compared with the barometrical charts immediately above them, one universal fact will be found throughout the entire month. It is that on a line being drawn from the locus of highest to the locus of lowest barometer, it will invariably be cut more or less at right angles by the wind; and especially, that the wind will be found to strike the *left* side of the line, as drawn *from* the locus of highest barometer. In short, as by the ordinary well-known theory, the wind (in our hemisphere) when indraughted *to* an area of light ascending currents, whirls round in a *contrary* direction to the movements of the hand of a watch, so, conversely, when the wind disperses itself *from* a central area of dense descending currents, or of heaped up atmosphere, it whirls round in the *same* direction as the hands of a watch. I confidently appeal to these maps, and especially to the original MSS. whence these charts have been reduced, to confirm the theory.” (*Meteorographica*, p. 7, col. i.)

From the temperature charts Galton did not draw conclusions as epoch-making as from the pressure charts, perhaps he laid overmuch stress on the *direction* of the wind as the chief source of hot and cold areas; but when we persist beyond that first feeling of repugnance which the crudely hatched masses of red and black on his charts excite in our minds, we catch glimpses of broad generalisations, or if the reader prefers suggestions, of what might flow from the more accurate synchronous data plotted by similar methods for still more extended areas.

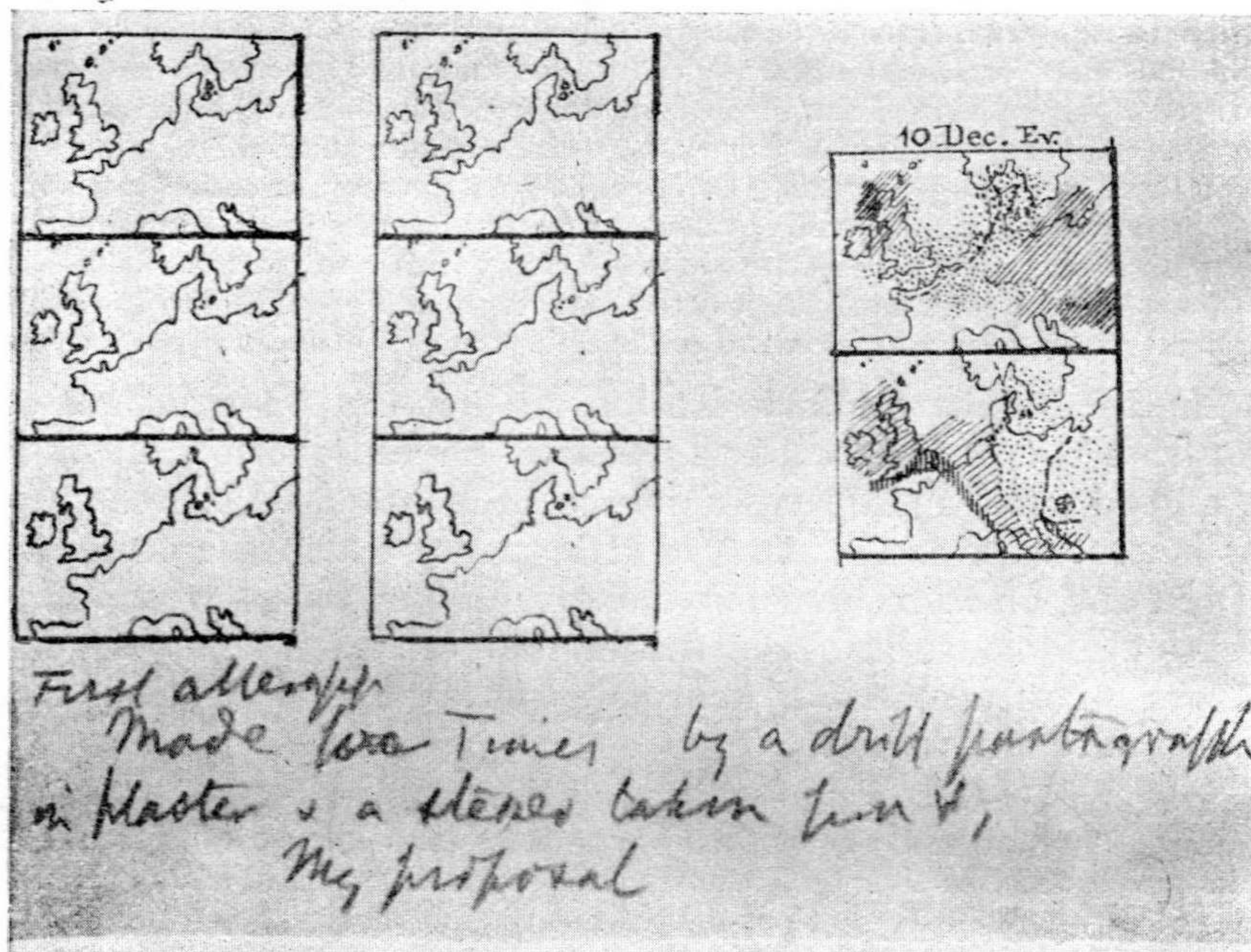
“The areas of barometric elevation and depression are enormous, and in their main features are very regular. They are easily recognised by the lithographic maps, in black and red. There is no case in which the Charts include the whole breadth or length of any one of these areas, and there are cases where clearly not one-half of them is included, yet the map is about 1,200 geographical miles in height and 1,500 in breadth. They do not move with regularity, ridge behind ridge, like waves of the sea, but they are ever changing their contours and their sections. They also vary in the speed and directions of their movement of translation.” (p. 7, col. ii.)

Galton had seen that Great Britain was not a large enough area for meteorological inquiry; he then attempted what might be learnt from what he terms an “enormous area,” only again to realise that 2000 miles is hardly adequate to exhibit at the same time a cyclonic and an anticyclonic system. He thus prepared the way for that world meteorology on which modern forecasting essentially depends, and which is now-a-days a commonplace of our daily papers.

Nay, it is to Galton himself that we owe those little weather charts which form a familiar item of our morning news, e.g. in the *Times* newspaper. There is a little series of maps in the *Galtoniana* of the Galton Laboratory of which the diagram on page 42 is a reproduction, under which Galton has written “First attempt made for *Times* by a drill pantagraph in plaster and a stereo taken from it, my proposal.” The maps are for December 10, Evening, and show by different types of shading the areas which lie between certain ranges of the meteorological characters¹. It is interesting to compare

¹ Galton does not on these first maps state what characters were represented by the two systems, probably pressure and cloudiness; there are no indications of wind direction and no printed figures.

Galton's suggestions with the isobar maps of to-day, still giving wind by arrows, recording temperature by figures and state of the heavens in words. This original meteorological map for the *Times* must have been at a later date than we are now considering, perhaps about 1869, as the drill pantagraph must have been previously constructed.



But I cannot find that it was ever published. The first issue of a weather-map in the *Times* was on April 1, 1875, and we give on p. 43 a reproduction of it. An account of the matter was published in *Nature*, April 15, 1875. We give a few sentences from it:

“The method of preparation of the chart seems simple enough at present, but it has been the fruit of much thought, as the problem of producing in the space of an hour a stereotype fit for use in a Walter machine has not been solved without many and troublesome experiments.”

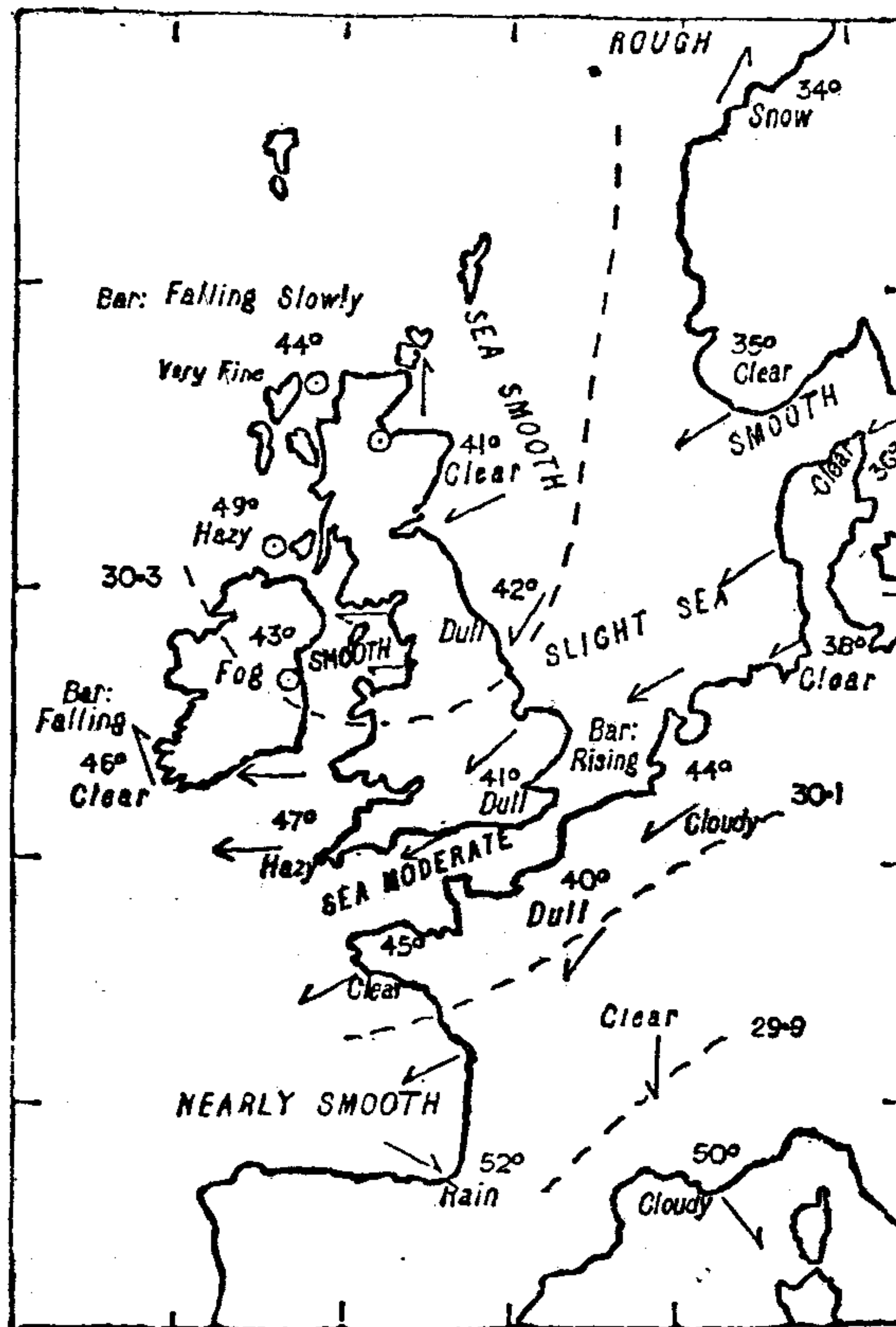
Then follows a brief description of the material, the drill pantagraph (see our p. 46) and the engraving of the block.

“The initiative in this new method of weather illustration is due to Mr Francis Galton..... It is hardly necessary to allude to the value of such charts as these as a means of leading the public to gain some idea of the laws which govern some of our weather changes.”

The *Shipping Gazette* started publishing on January 4, 1871 a daily chart for the winds round the coast of the British Isles on the basis of reports telegraphed to the Meteorological Office. It states in its issue that “this new system of showing the direction and force of the wind by movable types etc. has been entered at Stationers’ Hall.” After Galton’s maps of 1861 and 1863, it is difficult to see why the system should be called ‘new.’

The publication of the *Meteorographica* placed Galton at once among

the leading English meteorologists. The history of weather forecasting in England starts from Admiral R. Fitzroy of 'storm cone' fame¹. By his exertions the English Meteorological Office was founded in 1854. Fitzroy had more enthusiasm than science. On his death in 1865 the Board of Trade appointed a small departmental committee to consider the whole subject. It consisted of Mr (afterwards Lord) Farrer, then permanent secretary of the



The dotted lines indicate the gradations of barometrical pressure, the figures at the end showing the height, with the words "Rising," "Falling," &c., as required. The temperature at the principal stations is marked by figures, the state of the sea and sky by words. The direction and force of the wind are shown by arrows, barbed and feathered according to its force. ☉ denotes calm.

Galton's Weather Map, *The Times*, April 1, 1875.

Board of Trade, Captain Frederick Evans, the Hydrographer, and Francis Galton. They reported in 1866, and as a result of their report the Meteorological Committee was appointed in 1868 with Galton as a member. This committee worked for some years, but it was felt that a wider scope of action was desirable, and after a second Government committee appointed by the Board of Trade and Treasury conjointly, Galton again being a member, it emerged as the Meteorological Council, and of this Galton was a member until 1901.

¹ Better known to some of our readers as the Captain Fitzroy of the *Beagle*, the surveying ship on which Charles Darwin sailed as Naturalist.

Thus for nearly forty years Galton was intimately associated with both the theory and practice of meteorology in this country. In a letter to Galton on his resignation from the Meteorological Council in 1901, the then chairman, Sir Richard Strachey, wrote :

“It is no exaggeration to say that almost every room in the Office and all its records give unmistakable evidence of the active share you have always taken in the direction of the operations of the Office. The Council feel that the same high order of intelligence and inventive faculty has characterised your scientific work in Meteorology that has been so conspicuous in many other directions, and has long become known and appreciated in all centres of intellectual activity¹.”

We have already seen how the importance of a knowledge of climate to the traveller and explorer led Galton to study meteorology; but as soon as this subject had ‘gripped’ him—as every new subject he attacked did—he recognised the importance the explorer had as a contributor to meteorological science. He also realised how much help could be obtained for this science from residents and officials abroad. Thus he prepared for the Meteorological Society about 1862 a pamphlet entitled: “Meteorological Instructions for the use of inexperienced Observers resident abroad.” This pamphlet Galton in his collection of papers inscribes “Meteorological Instructions for Travellers.” He writes:

“The following instructions have been framed to facilitate the labours of those who have little leisure and experience in conducting meteorological observations, and show the minimum of effort with which trustworthy results can be obtained.” (p. 2.)

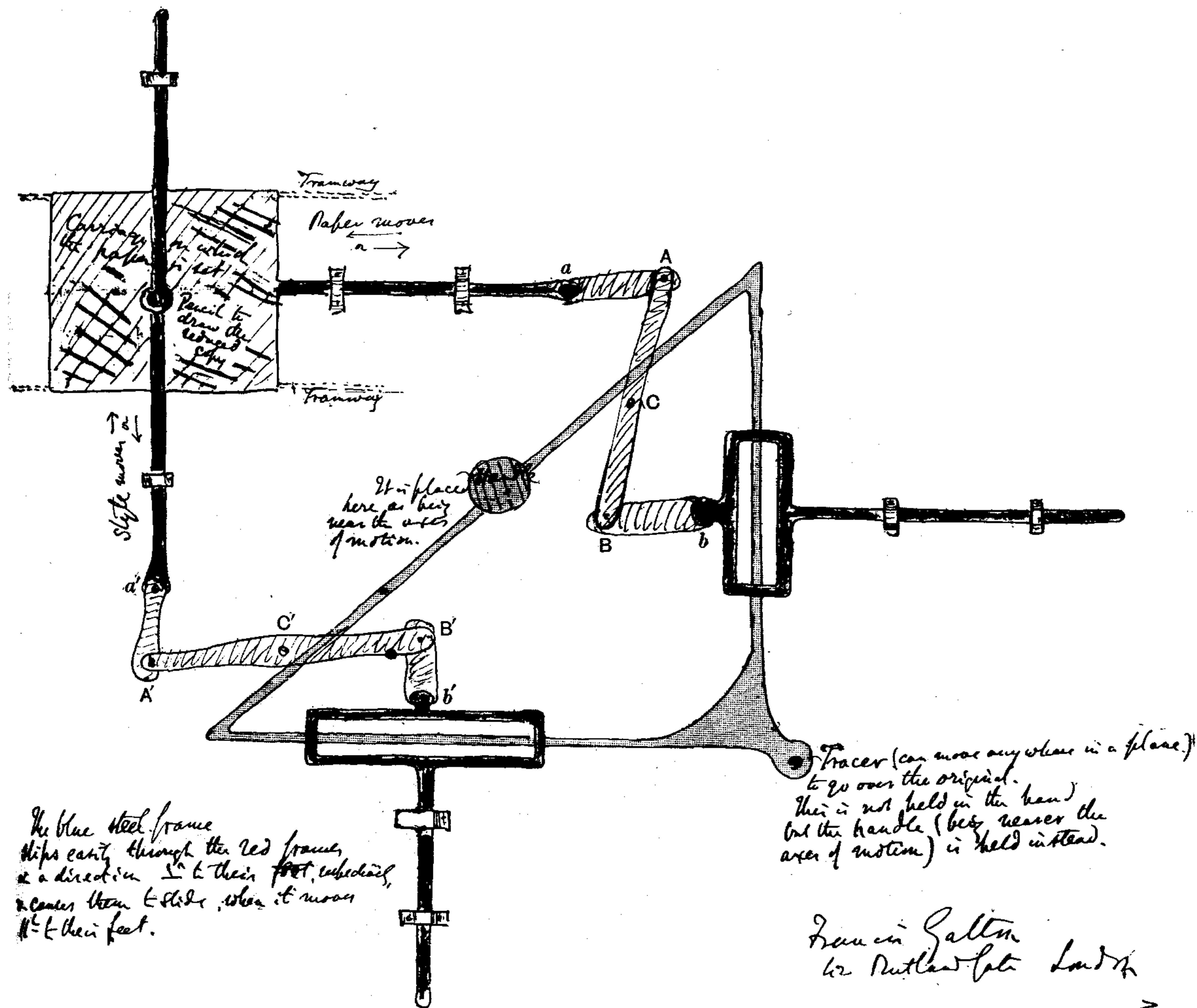
The Meteorological Society provided four instruments at a small cost,—maximum thermometer, minimum thermometer, and an ordinary thermometer, with a rain-gauge, and it is the efficient use of these which Galton describes. The object was to obtain mean monthly temperatures, monthly ranges, rain and wind returns. There is no reference to barometric pressure. Geographical position and a determination of the meridian (for wind observations) are also referred to.

To Galton also must be given a large share of the credit for devising and organising well-equipped self-recording meteorological observatories. Continuous photographic tracings were arranged for the chief meteorological instruments. These are very familiar now, but they required much time and thought in those early days of meteorology and photography². When these ‘tracings’ were obtained they were not in a form for reproduction and publication, and the difficulty, which meets the editor of every journal, was encountered by Galton, namely: How can diagrams be reproduced so as

¹ Letter of May 9, 1901 from Meteorological Office. It would be impossible to enumerate here all Galton’s work for the Meteorological Committee. The index to its *Minutes* must be consulted by those desiring further information. His plans from anemometers and pantagraphs to methods of “weighting” ship-logs, of lithographing and charting are scattered broadcast through these *Minutes*. Galton devised a “Torsion anemometer” and a “Hand anemometer” for use on ships. The latter may still be seen in the Science Museum, South Kensington. See *Catalogue of Meteorology*, pp. 53, 61, 1922.

² “I had the satisfaction in its [i.e. Meteorological Council’s] early days, when new instruments and methods were frequently called for, of being able to do my full share of the work.” *Memories*, p. 234.

to reduce the scales in two directions at right angles in any desired and *different* ratios? A photograph, or with more labour a pantagraph, will reduce in *both* directions in the *same* ratio, but this is not what is needed. A contributor of a memoir rarely pays any attention to the proportions of the page in which he desires his paper to appear, and then it is a mere chance whether his diagrams however neatly constructed can be used without re-draughting. The ideal remedy would be a photographic process of bi-directional

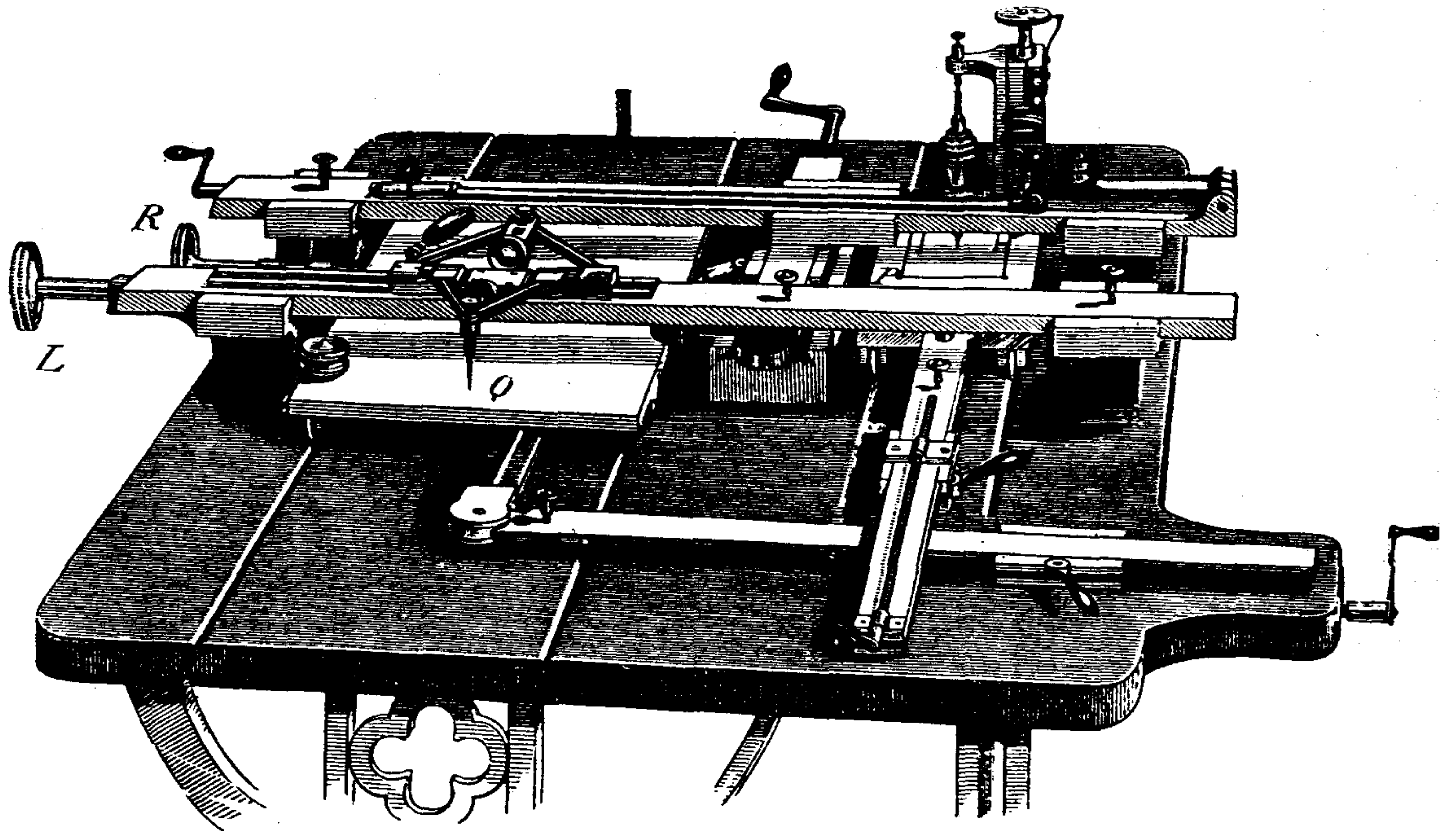


One of Galton's original designs for double pantagraph, coloured in the actual drawing.

reduction, because photography is so much shorter and cheaper than pantagraphic work. The difficulties as to distortion of lettering would be overcome by pasting on the printed lettering to the reduced photograph, instead of to the original drawing. But although this topic more than once formed the subject of long talks of the present writer with Francis Galton, no

practical photographic scheme was then evolved¹. The difficulty of bi-projection met Galton at a very early stage of his meteorological work, and he solved it by the construction of a compound pantagraph. He gave a great deal of thought to the subject, and his papers contain numerous devices and suggestions for an instrument of this character. His work upon it began in 1867, but was not completed till 1869, when the first compound pantagraph constructed by Mr C. Beck was placed in the Meteorological Office.

The general idea is that of a double or compound pantagraph. The tracing pointer has a horizontal and a vertical motion. The former is conveyed through one pantagraph to the drawing-board on which the paper for reproduction is set and the latter through a second pantagraph to the reproducing pencil or style. The design on page 45—not the one finally adopted—in Galton's autograph indicates his ideas. The two pantagraphic linkages $aACBb$ and $a'A'C'B'b'$ are the fundamental features. C is a fixed pivot which may be either in AB or in a continuation of the rod AB ; then if the lengths of aA , CA , CB and Bb be so adjusted that the triangles CAa and CBb are similar for any one position of those triangles, they will be similar for all positions, and consequently the distances a and b move in their constrained horizontal paths will be in the adjustable ratio of CA to CB ².



Galton's double or drill pantagraph.

¹ We shall see later that Galton actually solved the problem, but did not publish his solution. A simple 'bi-projector' was made for the writer by Mr Horace Darwin many years ago for drawing parabolae, ellipses, probability curves, etc., but it involved the cutting of a definite metal template for each type of curve; it might possibly be adapted for reducing drawings.

² This fundamental principle of Galton's compound pantagraph is discussed by him with proof in a letter of July 15, 1869, but he was inquiring for a maker even in May of 1869.

Perhaps a simpler arrangement would be to replace the linkage by pins at a and b running in a slotted bar turning about a pivot C . We reproduce (page 46) an illustration of the final apparatus; the pencil or style could be replaced by a drill¹. With this instrument for twelve years the *continuous* automatic weather records for seven stations (velocity and direction of wind, dry and wet bulb thermometers, barometer, vapour-tension and rain) were reduced to manageable dimensions and published. Of this publication Galton remarks:

“It surprises me that meteorologists have not made much more use than they have of these comprehensive volumes. But there is no foretelling what aspect of meteorology will be taken up by the very few earnest and capable men who work at it. Each of them wants voluminous data arranged in the form most convenient for his own particular inquiry².”

Probably the use has not been made of these graphical charts that might well have been made; but Galton's own results indicate that we need *simultaneous* data for a far wider range than Great Britain, and further modern methods of multiple correlation, which seem likely to be most productive of result in present day meteorology, demand numerical values, and these are hard to obtain from the graphs; not only can they scarcely be read off with the requisite accuracy, but to reconvert the graphs into any numbers whatever is in itself a most arduous task.

Galton's compound pantagraph has indeed a far wider field of usefulness than reducing automatic weather returns. The difficulty is that it is not made commercially and procurable at a moderate cost.

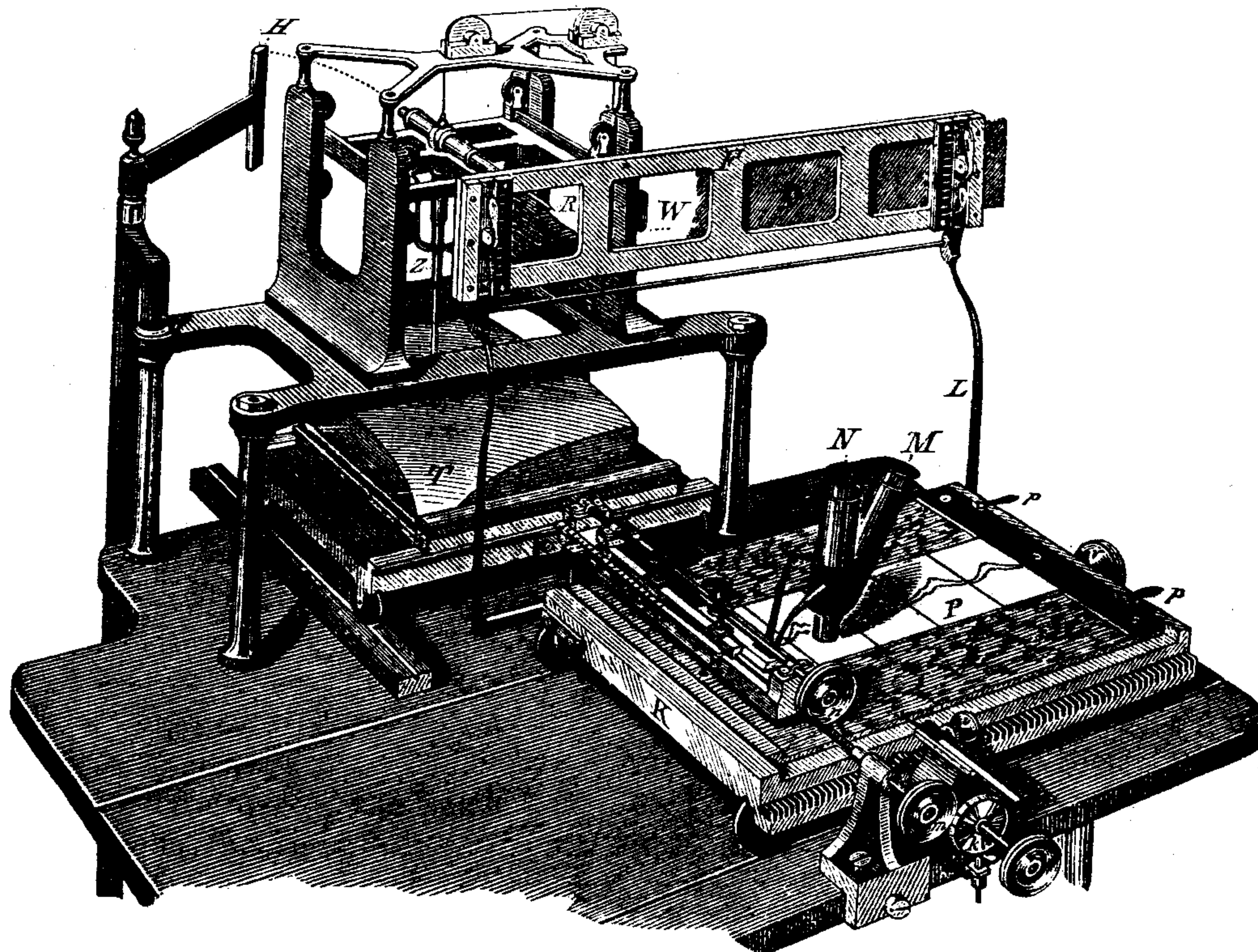
A second instrument devised by Galton about this time will be found described in the *Report of the Meteorological Committee*, 1871 (p. 30). It was devised for obtaining mechanically the vapour-tension curve from the curves of dry and wet bulb thermometers, but again it can be used to serve a much more general purpose, namely to obtain the curve of a variate whose ordinate is a given function of the ordinates of two other curves—all three curves having the same abscissa. The machine depends upon the construction of a surface corresponding to the function the variate is of the two other ordinates (i.e. in Galton's case the vapour-tension in terms of wet and dry bulb thermometer readings). By fine screw adjustment the cross-hairs in two microscopes are brought into accordance with the tops of the ordinates in the two curves, but the screw which adjusts one microscope moves the surface parallel to one axis, and the screw which adjusts the other microscope moves the surface perpendicular to this direction. Thus a vertical style resting on the surface raises to an adequate height a scribe which marks the ordinate or function-value of the compound variate³. It would be out of place here to give a more complete account of the instrument, but my more mechanically minded readers will grasp the general idea from the

¹ The theory is fully described in the *Minutes of the Meteorological Committee*, 1869, p. 9. It is also figured in the *Katalog mathematischer Modelle, Apparate und Instrumente*, of the Deutsche Mathematiker-Vereinigung, 1892, p. 232.

² *Memories*, p. 236.

³ In Galton's actual instrument (see our p. 48) the required curve was recorded on a zinc plate (partly removed in figure to show scribe R). The scribe received when adjusted a blow from the hammer H worked by the action of the operator's foot on a treadle.

accompanying figure. Galton constructed his surface from a table of 400 values of the vapour-tension, 400 holes being bored into a solid rectangular block to these 400 values spaced properly apart, and then the remainder cut away, filed and smoothed. The construction at that time did not cost more than £6. Here again it is easy to think of many purposes to which a machine of this kind could be put, but as it has never been made as a commercial article, it has never come into general use. Perhaps this brief notice may remind investigators of the existence of Galton's design.



Galton's Trace Computer—a machine for tracing a curve, whose ordinate is any arbitrary function of two other variate values at the same abscissa or time.

A third instrument designed by Galton a little earlier (1867) never came in being, owing probably to a discouraging letter from Balfour Stewart at that time at the Kew Observatory, who laid great stress on comparison of pairs of automatic meteorological records at different intervals. Galton was easily discouraged and was apt to treat the judgments of the really able people whom he consulted as sure to be better than his own. It certainly was a pity that in this case he was put off completing his model. It was of the following nature: a map is mounted horizontally on, let us say, a metal plate; then holes are drilled at each meteorological station, and a rod of a convenient length is free to move vertically up and down in the hole. Templates are now cut to the continuous automatic records of any meteorological character for these stations and are fixed in vertical planes

running east and west on a carriage which runs east and west on rails under the map. Let us suppose the top of the rods to rest on the templates; then if the templates be adjusted by shifting east and west, so that the rods all rest on the points of the templates corresponding to the same instant of time, their tops will mark the contemporaneous value of the chosen variate at that time; and, if the stations be fairly numerous, will indicate a sort of surface of the variate. Let now the carriage be moved along, and the surface will change with the time, and the eye will recognise how the fall in one area is accompanied by a rise in another. For example we should actually see a cyclone or anticyclone passing along.

As a matter of fact Galton linked up his vertical rods with his templates by a system of levers, and this might be needful for one or two stations absolutely in the same latitude, but the cheapest construction would be fairly light rods ending with knife-edges to rest on the corresponding templates. He proposed also to convert the up and down motion of the wind curves into the angular motion of an arrow turning round a vertical axis at the station on the map. Galton's drawing of his apparatus is dated April 6, 1867, Sorrento, Italy, and his description of it April 11, 1867¹. Mrs Galton's diary says that they travelled to Italy at the end of January 1867, "staid chiefly in Rome and Naples and the neighbourhood of Venice, then by S. Tyrol to St Moritz, where the cure did wonders for me, but did not suit Frank." Then the Galtons went to Heidelberg and Bavaria; reaching England in October, where after a round of visits they settled in London by the end of November. Such were the conditions under which Galton had largely to do his work! One is forced to believe that he walked and thought, and his pocket notebooks suggest that he jotted down his diagrams and rough calculations at odd moments.

D. OTHER MECHANISMS

We have already referred to 'Galton's Toys,' models made up of strings, pieces of wood, lenses, or often of card and bits of glass only, which it is now practically impossible to interpret. But these 'Toys' are not all, there are constantly diagrams and schemes for instruments or the improvement of instruments among Galton's papers. I take almost at random a bundle with papers dating from 1858 to early in the 'seventies; this contains *inter alia* the following packets:

(a) One entitled "Examination of Sextants." It appears that at Galton's suggestion in 1858 the General Committee of the British Association passed the following resolution:

"That the consideration of the Kew Committee be requested to the best means of removing the difficulty which is now experienced by officers proceeding on Government Expeditions, and by other scientific travellers in procuring instruments for determination of geographical positions, of the most approved portable construction, and properly verified. That the interest of geographical science would be materially advanced by similar measures being taken by the Kew Committee in respect to such instruments to those which have proved so beneficial in the case of magnetical and meteorological instruments."

¹ Balfour Stewart's letter is dated Kew Observatory, May 1, 1867.

This resolution led to Galton being placed on the Kew Committee, and to an endeavour being made to raise the standard of angle-measuring instruments in this country, and their comparison with those of foreign make. The Royal Geographical Society was approached in the matter and that Society passed a resolution to offer a prize of £50 or a gold medal to the "Designer or maker of the most serviceable Reflecting Instrument for the Measurement of Angles"—doubtless at the instance of its Honorary Secretary. There exists a whole series of letters to Galton on the point. Sir Edward Sabine in a letter of Feb. 16 refers to both resolutions as Galton's. The latter proposed a Kew certificate for sextants, and a study of errors due to special forms of mercurial horizon, as well as of those peculiar to the prismatic compass.

(b) But Galton did not confine his attention to the above instruments. In 1864 Casella brought out a pocket 'altazimuth,' "improved and modified by the kind assistance of Francis Galton Esq. F.R.S." It could be used in two positions, in one as a good azimuth compass, and in another as a weighted disc for altitudes. It could also be used as an ordinary compass or as an ordinary clinometer¹.

(c) Galton also designed for Casella a small pocket instrument termed a *Zeometer*² (from Greek ζέω, boil), by means of which with an ounce of water and drachm of spirit the height of any mountain could be obtained and index correction of the aneroid determined; Galton provided a table of corrections for cases in which there was a considerable portion of the mercury in the stem of the thermometer outside the vessel containing the boiling water, and this table accompanied the directions for the use of the *Zeometer*.

(d) There is the design of another instrument to show by the action of a piece of catgut or of whalebone strips on the motion of a clock the number of hours per day in which humidity has exceeded a datum value. Galton considered that a similar arrangement could be made for temperature.

(e) Details of a linkage for determining the conjugate foci of a lens mechanically³.

(f) A note on lighthouse signals. Galton notes that the period of a complete breath is very nearly and very regularly four seconds. That this four seconds as a period recognisable by everyone should be taken as the base unit for lighthouse flashing signals.

(g) The original design of the hand-heliostat, with diagrams of its working and a water colour illustration of the field of view with the mock-sun covering the requisite flash point of the landscape. See p. 19 above.

(h) An instrument termed the "Tactor" machine. The diagram shows it to consist of two levers each with a tooth working on one of two complicated eccentrics on the same axis and apparently causing certain blocks to rise, fall and grip. I have no idea for what purpose the "Tactor" machine

¹ There exists still Galton's determination by aid of it of the latitude of Rutland Gate!

² There are very full details for the construction of this instrument, apparently in the draft of a letter to Casella.

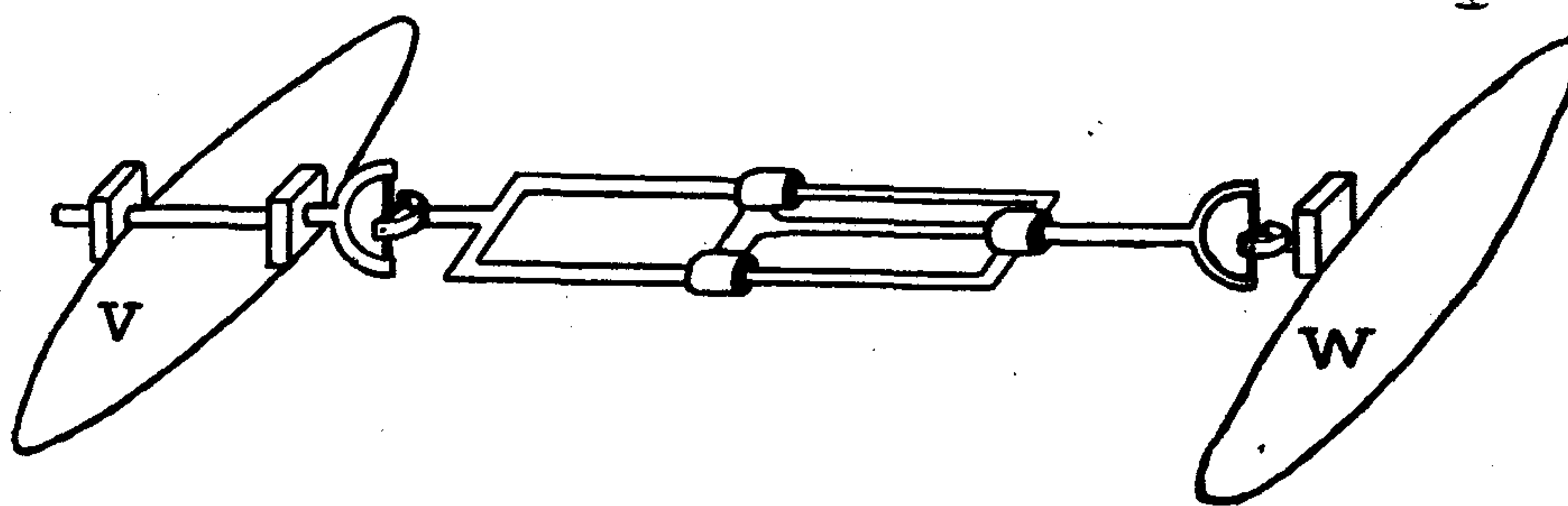
³ This occupied Galton again later, when he was busy with photographic change of scales, and in conjunction with Mr (now Sir) Horace Darwin a very reasonable linkage was devised to keep object and focal plane image at their proper distances from the optical centre of the objective.

was designed, and there is nothing but the design, no accompanying description to explain matters.

(i) A very detailed account of the "Wave Engine" in two notebooks dated 1871-2. Galton was very busy during these years with an endeavour to invent an engine by which the energy of waves might be rendered available for useful work, and in particular for the propulsion of ships. Galton's attention was probably first drawn to the matter by the difficulty there is in getting from an open boat on board a vessel at sea.

"Those who in rough weather have had occasion to get on board a vessel at sea are well aware of the large and rapid changes of relative position between the boat and the vessel. At one moment the boat has to be fended off from the sides of the companion ladder against which it is violently dashed, at another it is lying many feet below its lowermost steps. No ordinary activity and presence of mind are required in a person unaccustomed to the rhythm of these changes to seize the exact moment when it is possible to jump onto the ladder without accident. Even if the waves be so short compared to the length of the vessel that she rests in perfect steadiness while the boat is tossing about, the difficulty of embarkation is still very great, for the rise and fall of the boat is 4 feet in moderate weather in a roadstead like Spithead¹ (of course it is much more in the open sea) and it will be repeated perhaps 12 times in the minute. It is clear that this energy might be made to do work, if the boat were secured to the end of an arm, moving vertically up and down like a pump handle, that handle might be connected with suitable mechanism and caused to perform useful work."

The simplest conception is that of a buoy attached to a lever with fixed fulcrum; the up and down motion of the lever may be turned to useful work. Galton calculates a table of wave energy, measured in horse-power per ton of surface water. Thus for a wave of 5 ft. height (from trough to crest) with a period of 5 seconds, and a vessel displacing 1 ton of water, the horse-power would be 1.3. Galton next takes two vessels *V* and *W* and he proposes to link them together in such wise that they have complete liberty within the range of the slide which forms part of the "link."



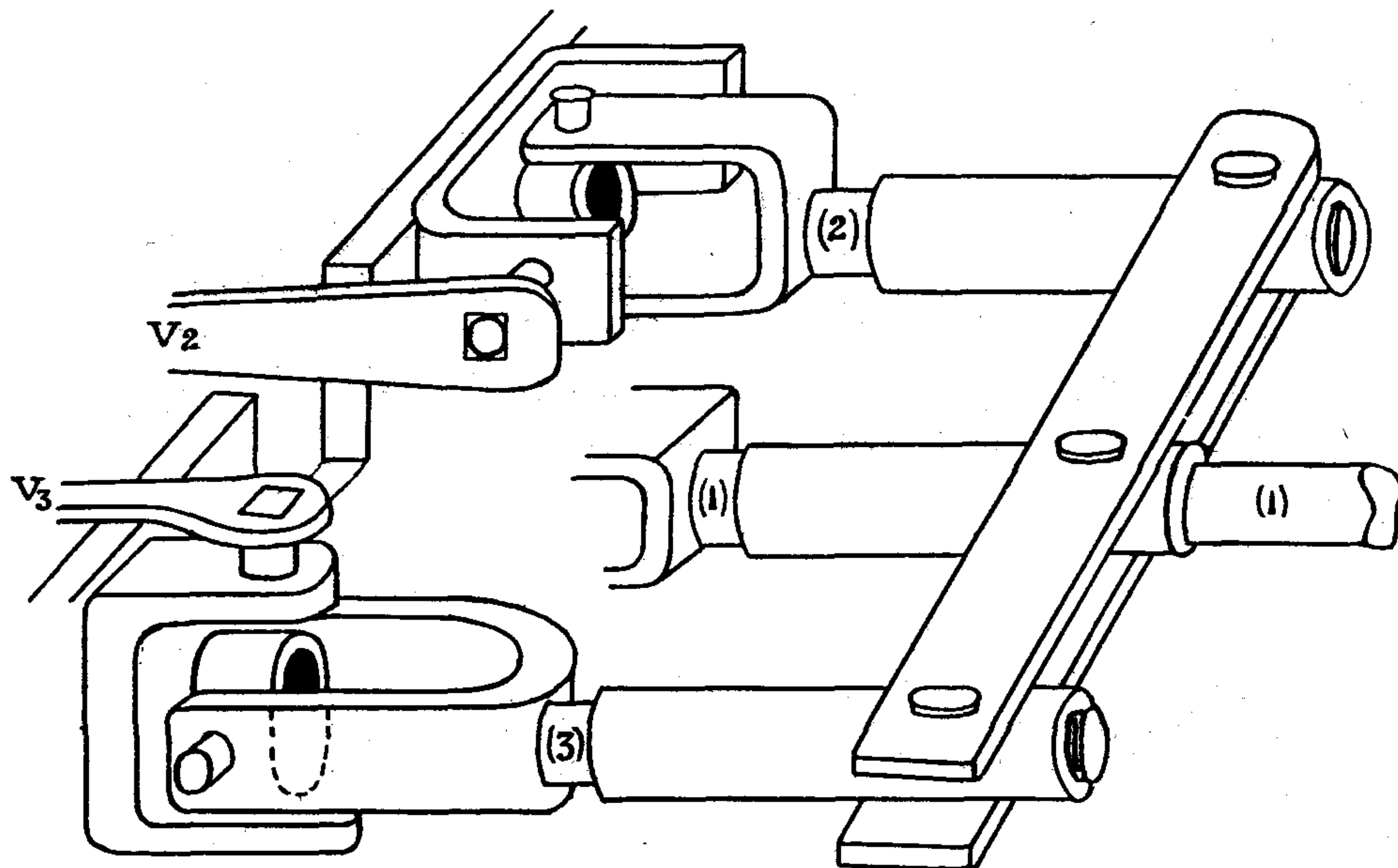
"The link consists of a Hooke's joint at the side of *W*, which allows *W* to roll and to yaw,—it will be obvious that the same movement which permits rolling obviously includes heaving. An

¹ A few extracts from *L. G.'s Record* throw light on these years: "Frank gave up his rabbit-breeding and took to machine inventing.... We were at Southsea enjoying the Dockyard at Portsmouth, and the sight of the great ships of war. Captain Hall took us about in his steam launch. We went over the Wellington, the Victory, the St Vincent training ship, the Queen's Yacht the Enchantress, and the Monarch and Devastation, the great ironclads, also the Trafalgar previous to its sailing next day.... Frank taken up with spiritualism and attended meetings at Mr Crookes's and Mr Cox's. We went to Brighton for the British Association, and Emma [Francis Galton's sister] joined us on the 10th [August]. Frank President of the Geographical Section. Stanley made himself most conspicuous and obnoxious" [see our p. 30].

axle passing across V allows the relative pitching and tossing of the two vessels. This axle is connected by a Hooke's joint which allows exactly the same movements of rolling (inclusive of heaving) and yawing to V that the first-mentioned joint did to W . And lastly the two Hooke's joints are connected by a sliding arrangement, which permits the vessels to approach or separate from one another within the range of the slide."

"In the case I am about to consider, I will suppose the three motions consisting of (1) the relative pitching of the two vessels, (2) the rolling of V and (3) the yawing of V to be transferred to a 'wave engine' on V , and the other three motions consisting of (1) the relative separation (or approach) of the two vessels, (2) the rolling of W and (3) the yawing of W to be transferred to the 'wave engine' on W ."

The bulk of Galton's paper is then concerned with the mechanical arrangements by which every phase of the relative motion of the parts of the "link" can be applied to producing rotatory motion on V and W . Such mechanical arrangements constitute the "wave engine." To describe them would take us beyond our proper limits, but they exhibit all Galton's ingenuity from the mechanical side. I do not know whether any one had considered previously the possibility of using the relative tossing and pitching of two hulks as a source of power.



Part of the drawings for Galton's "wave machine."

Galton consulted three friends about his "wave machine"—Mr C. W. Merrifield, the Rev. H. W. Watson the mathematician, and Mr George Darwin. Merrifield considered the matter at considerable length with regard to the horse-power available, the actual mass in motion and the friction. He sums up as follows:

"My theoretical conclusion is therefore against the machine being of practical utility, by reason of its probable efficiency not being adequate to its cost and its inconvenience. I consider, however, that both the idea and the machinery are ingenious in a very high degree; and I should be sorry if you allowed one adverse opinion (coming from myself) to discourage you from trial."

Galton seems at first to have had an idea of utilising his relative motions to work some form of air-engine, and it was about this phase of his invention that he wrote to Mr Watson, who replied as follows:

"I am truly rejoiced to find that you are so sanguine. I am confident you have hit upon something real, and not a chimaera, and only hope you may be able to bring it to some practical end. I am not inclined to think you could utilise the power you have discovered in the way you suggested."

Galton had also suggested that motive power for a double ship might be obtained from the relative motion of its twin parts, and this point is taken up by George Darwin:

"I will keep your secret strictly. I am glad to hear that you are going to patent it, as it sounds as if it ought to be a great mercantile invention

Will it be possible to unyoke your ships? If not they would be rather unmanageable in rivers and harbours. Will not the danger of collisions be much increased by the great width and what will happen when the helm has to be turned hard to avoid anything? If one of the ships got at all out of hand, it would be rather an awkward combination wouldn't it? My father is very incredulous *in re* the spirits. I am sorry to hear that Miss F. is to have her familiars with her as 3 conjurors could combine to do their tricks without much chance of being found out¹."

Whether it was Merrifield's criticism or George Darwin's irony² which led Galton to abandon his scheme, I cannot say; a last letter from Merrifield indicates that in April 1872, Galton was proposing to employ his apparatus to measure the energy of a sea-disturbance. Galton's idea, which must of course be distinguished from the use of tidal energy, seems to possess much originality. As our coal and oil supplies run short, possibly men will turn again to Galton's suggestion of harnessing the waves.

E. CLIMATE (*continued*)

A meteorological paper of August 1866³, read before the British Association in that year⁴, deserves a passing notice. In this paper Galton criticises the statistical methods of the old Meteorological Office—otherwise of Admiral Fitzroy. It is entitled: "On an Error in the usual method of obtaining Meteorological Statistics of the Ocean." He points out that the

¹ See our p. 51 *ftn.* Galton's investigation of spiritualism interested Charles Darwin and will be referred to again later.

² Major L. Darwin assures me that the irony would be quite unconscious on Sir George Darwin's part.

³ *B. A. Report*, Vol. xxxvi, 1866 (Sect.), pp. 16-17. Also *Athenaeum*, Sept. 1, 1866. We may just mention in this footnote that in the previous year (October 1865) Galton wrote a long notice in the *Edinburgh Review*, pp. 422-55 of J. F. Campbell's *Frost and Fire*. There was much in this book to interest Galton and excite his criticism and suggestion; thus he explains from close observation (p. 433) that trees do not as Campbell suggests 'bend to the wind,' they bend under the weight of branches, which can only flourish on the lee-side of the trees.

⁴ Read by the Secretary of the Section as Galton was ill at the time. He had gone to the British Association at Nottingham, but had been "done up and obliged to leave." The Galtons then went to Leamington where "Dr Jephson prescribed for Frank, he grew very weak under the treatment. End of September returned home and remained six weeks, then went to the Norths, and took lodgings at Hastings in Breeds Place; stayed there till near end of January 1867. Frank rode constantly." *L. G.'s Record*. It was this illness which probably led Galton to resign the Secretaryship of the British Association and spend much of 1867 in travel.

ocean being divided into areas of 5° angle in longitude and latitude, and the ship returning *all* its observations, subject to the sole condition of an interval of eight hours between observation and observation, a ship will give more observations when the wind is unfavourable than when it is favourable; accordingly there will be an error produced—since favourable and unfavourable winds are peculiar to certain areas, and ships outward and inward bound follow different courses—in taking not only the mean direction of the wind for certain areas but also in other meteorological variates highly correlated with the wind, such as temperature and dampness. The remedy would be to enforce not only an interval in time, but an interval in distance of the positions of successive observations.

Galton's criticism is of less importance now that steamships have replaced sailing vessels, but the paper is of interest as marking probably the first occasion on which Galton exhibited publicly his fine instinct for the discovery of statistical fallacies.

The reader will not appreciate Galton's work at this period unless he remembers that Galton's earliest travels were associated with *sailing* ships; it was in such a vessel, the *Dalhousie*, that he sailed for Africa; and he thought for many years of his life in terms of wind and not steam as a motive power¹. Thus it came about that when Galton turned his study of meteorology in the direction of ocean travel, he thought in terms of sailing vessels. The wind had for Galton a singular fascination, and for him the problem always was: What can we learn from the wind, how can we make it of greatest service?

Three or four of his papers touch on wind problems, and these we will now briefly consider.

The first one that may be referred to is entitled: "Barometric Predictions of Weather," and the paper was read at the British Association Meeting in 1870². Galton's paper is suggestive, because, what he is actually seeking for in his linear prediction formula of the velocity of the wind in terms of barometric height, temperature and damp is what is now familiar to statisticians as a multiple regression formula. Galton very properly saw that the relation of barometric height to wind-velocity did not depend upon the instantaneous wind, and he accordingly experimented with average wind-velocity for a series of two, three, etc. hours. He came to the conclusion that the best period for the average was about twelve hours. He considered that twelve hour averages should also be taken for temperature and damp. Galton easily found his averages from the automatic record of continuous temperature, wind-velocity and damp. He explains clearly why he takes an average, namely the barometric pressure acts in sympathy with a much larger wind-velocity area, than that immediately in its own neighbourhood. The pressure (as in the case of water) is affected some time

¹ I think this is true even as late as the early 'seventies when Galton was busy with his "wave engine" (see p. 51). Such an engine as a propulsor would hardly have occurred to one who had grown up in an era of steam vessels.

² *Brit. Assoc. Report, 1870, Trans. Sections*, pp. 31-33; *Nature*, Vol. II, Oct. 20, 1870, pp. 501-3.

before the arrival of the centre of greatest disturbance. Accordingly Galton reaches a formula of the form

$$h_1 - h_2 = m \{v_1(12) - v_2(12)\} + p \{t_1(12) - t_2(12)\} + q \{d_1(12) - d_2(12)\},$$

where h = pressure, $v(12)$ equal average wind-velocity, $t(12)$ equal average temperature and $d(12)$ equal average damp for 12 hours round an epoch, and the subscripts 1 and 2 represent epochs of time at a few hours interval. Galton then determines in rough figures the values of m , p , q from observations at Falmouth. So far he might—by very crude methods indeed—be determining a multiple regression formula. But the next step he takes is erroneous; he transfers what amounts to v_2 to the other side of his equation, and proceeds to predict v_2 from barometric height, etc. It was not till much later that Galton realised that in the simplest case the prediction formula of v from h is not the same formula as that of h from v . Hence although his conclusion that average wind-velocity cannot be closely predicted from barometric height is true, his method really failed to demonstrate it rigidly.

“The barometer when consulted by itself, without a knowledge of the weather at adjacent stations, can claim but one merit, namely, to guide us in a form of storm which does not occur once a year in the British Isles, of a fall in the mercury outstripping in an extraordinary degree the increasing severity of the weather; and I believe it to be on account of this rare phenomenon here, and of the reports of sailors from hurricane latitudes, where it is much more frequent, that the fame of the instrument has been so widely spread.”

With his usual instinct Galton had reached a true conclusion, although his method was at fault. For us the interest of his paper lies in the evidence that he was feeling his way towards ‘correlation’¹.

A series of three papers must now be considered in conjunction. The earliest of these is entitled: “On the Conversion of Wind Charts into Passage Charts.” It was read in Section A of the British Association, 1866 (*Trans. Sections*, pp. 17–20), and published also in the *Philosophical Magazine*, Vol. xxxii, pp. 345–8, 1866. Galton explains his purpose in the following words:

“The most direct line between two points of the ocean is seldom the quickest route for sailing vessels. A compromise has always to be made between directness of route on the one hand, and the best chance of propitious winds and currents on the other. Hence it is justly argued that an inquiry into the distribution of the winds over all parts of the ocean is of high national importance to a seafaring people like ourselves. A knowledge of the distribution of the winds would clearly enable a calculation to be made which would show the most suitable passage in any given case². But as a matter of fact, no calculations have yet been made upon this base; much less have charts been contrived to enable a navigator to estimate by simple measurements the probable duration of a proposed voyage. The wind charts compiled by the Meteorological Department of the Board of Trade are seldom used by navigators; for they do

¹ Galton’s paper led to a long correspondence with G. H. Darwin (afterwards Professor Sir George Darwin), chiefly noteworthy because from this date an intimate correspondence sprung up and touched many other problems that Galton was considering in later years.

² Galton was clearly endeavouring to replace the straight lines and loxodromes of Mercator’s Chart by a modern theory which should take account of the variations of the wind—less suited indeed to the examination room, but of more practical value. How few Cambridge mathematical examiners appear to have realised even since Galton’s time the futility of loxodromics, which pay no attention to the individuality of the ship or the local characteristics of the wind!

not afford the results that seamen principally require; they are only data from which those results might be calculated by some hitherto unexplained process, which, we can easily foresee, must be an exceedingly tedious one."

It is this process which Galton proceeds to unfold for moderate winds in the case of a "merchantman of the class that usually navigates the Atlantic." To carry it out we require to know: (1) the proportionate time (or the relative frequency) that the wind blows in a given area from each of say eight points of the compass, (2) the number of miles that the particular ship will make in an hour at each angle to the wind. Combining these two results we can measure for the average of the winds in that area the average progress of the ship towards each point of the compass in an hour. If the distance reached¹ in an hour be plotted from a centre in the arc, we obtain a closed curve whose radius vector measures the efficiency of the ship in that particular area for a particular course. If now the chart be divided up into areas and in each area be placed the corresponding polar diagram, we have converted a wind chart diagram into a passage chart diagram. A navigator now plots his proposed course across these areas, and sets off with his compasses the distance run per hour in the direction of the course from the nearest polar diagram. In this way he is able to calculate the average time on the proposed course and can compare it with the time on other courses.

"He will thus be able to select the quickest out of any number of routes that may be suggested to him, and to determine, on the most trustworthy of existing data, what is the best course to adopt in sailing from one part of the ocean to another."

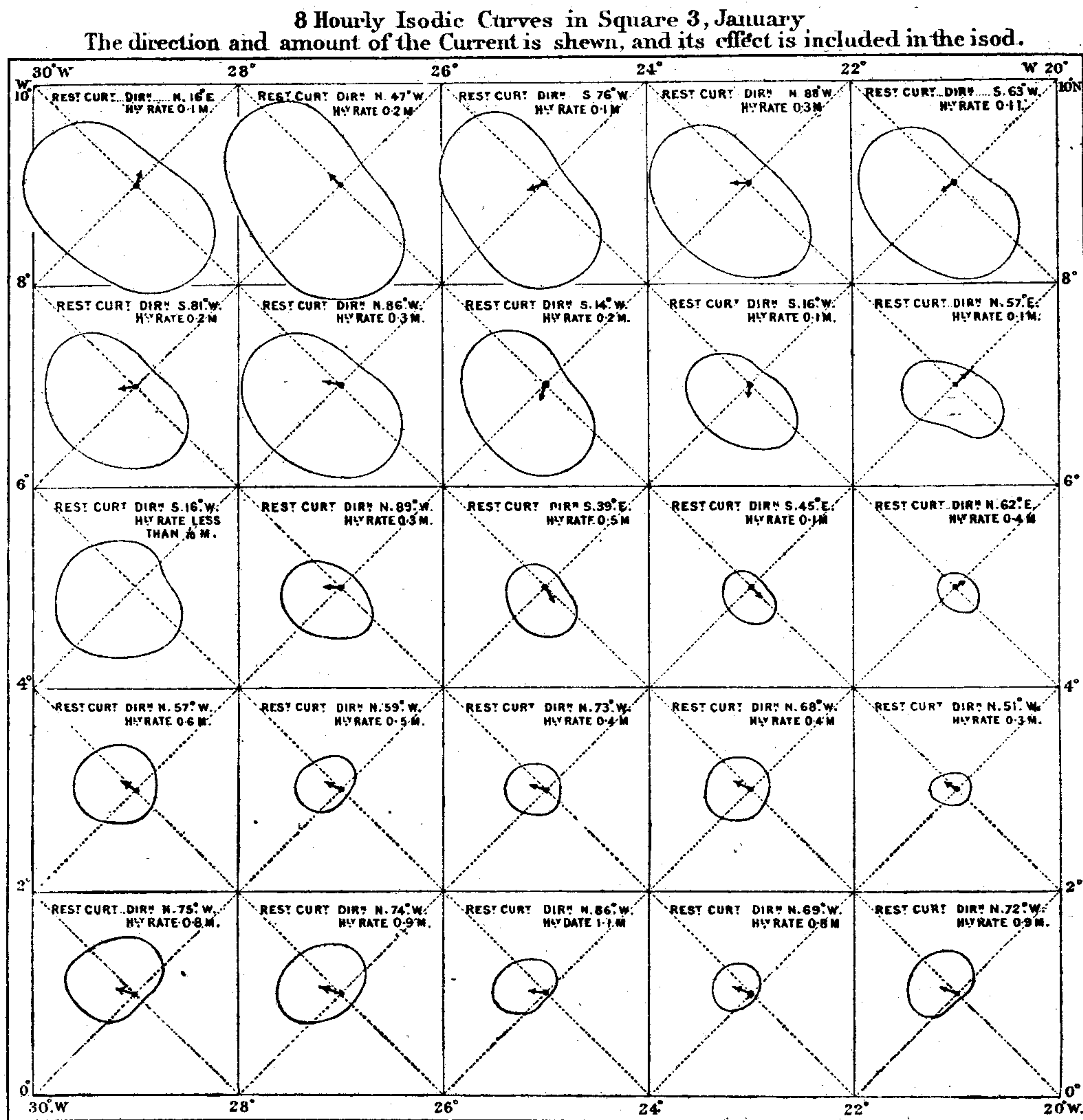
Galton suggests the modification of the polar diagram when (*a*) force of wind and (*b*) current are taken into account.

The next paper on this subject was published in the Minutes of the Meteorological Council for December 2, 1872². In this communication Galton advances a considerable stage further. The Meteorological Office had sorted out the whole of the data for direction and force of wind and for current into "single degree squares." Thus the resultant direction and strength of current, the average force of the wind and its proportional directions were more or less accurately known for each area, for each month of the year. Galton now terms the polar diagrams of his earlier paper "isodic curves" or briefly "isods." He calculates them for the month of January for "2° squares" from Longitude 0° to 10° N. and from Latitude 20° to 30° W., allowing for current, and force of wind as well as direction, and taking as his standard type the "Beaufort ship." The rays now represent the average space run in 8 hours, and Galton enters into details of how to construct 'isodic' charts and passages. He seems, however, to have been in some doubt as to whether his name 'isod' was appropriate. In his own copies of this paper, he questions in pencil whether the word should not be 'ishodic.' But another doubt must have arisen in his mind; his isods did not represent equal paths, but the paths

¹ Not the distance traversed, because to reach a given point the ship will generally have to tack.

² Presented to Sir Edward Sabine, the Chairman, Mr Galton, Major-General Smythe and Sir Charles Wheatstone.

run in *equal times*. Thus a suitable name would have been 'hodogram' had not something like that word been already appropriated in another and rather unfitting sense by Sir William Hamilton. Galton in his third paper, published in the *Royal Society Proceedings*¹, and entitled: "On the Employment of Meteorological Statistics in determining the best course for a



Note: REST CURT = RESULTANT CURRENT.

Specimen of Galton's Isodic Curves from Minutes of Meteorological Council, 1872.

ship whose sailing qualities are known," terms these hodograms "isochronous curves" or simply "isochrones." The discussion of the construction of isochrones, if somewhat fuller, follows here the lines of that in the *Meteorological Council Minutes*. A new feature is the description of a somewhat elaborate

¹ Vol. xxi, pp. 263-74, April 1873.

machine for plotting isochrones; the individuality of the ship is represented by zinc templates cut to its sailing qualities under each force of wind, and each template corresponding to the number of points the course of the ship lies off the wind. Galton considered that such templates could be cut for some moderate number of classes of ships, and charts of isochrones for such classes be then issued for the principal oceans. Galton remarks in his *Memories*¹:

“I was rather scandalised by finding how little was known to nautical men of the sailing qualities of their own ships, along each of the sixteen points of the compass, assuming a moderate sea and a moderate wind blowing steadily from one direction. I think, if I had a yacht, that this would be the first point I should wish to ascertain in respect to her performances.”

In his Royal Society paper he states that no human brain from a mere inspection of the crude data of winds, currents, etc. can deduce a correct result as to the distances likely to be run by a given ship on various courses.

“As an example, I may be allowed to mention², that I asked a naval officer of unusually large experience in the construction of weather charts, and who was familiar with the sailing qualities of a ‘Beaufort standard ship,’ to estimate portions of isochrones in certain cases; and I found the mean error of his estimates to exceed 15 per cent. The guesses of ordinary navigators would necessarily be much wider of the truth. Now we must recollect that a very small saving on the average length of voyages would amount to an enormous aggregate of commercial gain, and that, where precision is practicable, we should never rest satisfied with rule of thumb. Our meteorological statistics afford the best information attainable at the present moment, and they exceed by some hundredfold the experiences of any one navigator; their probable errors may be large but that is no reason for needlessly associating them with additional subjects of doubt. The probable error of a navigator’s estimate of an isochrone, and consequently of the data which he must use, whether consciously or not, whenever he attempts to calculate his best track, is due at the present time to no less than three distinct sets of uncertainties: (a) the average weather; (b) the performance of his ship on different courses with winds of different force (which I understand to be hardly ever ascertained with much precision); (c) the computation of the isochrone.”

Galton proposed to reduce the uncertainty to (a).

There is much of interest in this series of papers which are very characteristic of the author’s originality in idea and in method, but alas! the papers ought to have appeared 20 years earlier. The modern reader hardly realises that the bulk of our stores were carried in 1857 to the Crimea in sailing ships; that even at the time Galton wrote these papers a considerable proportion of trade was still carried by sail. Published in 1850, these papers would probably have been followed by the universal construction and use of isochronic charts, and Galton’s name would have been honoured in the history of navigation. But in the ‘seventies steam was rapidly superseding sails, and sails were practically discarded before the Meteorological Office had time to collect the more ample and trustworthy data of ocean statistics, on the publication of which Galton’s charts depended. Each mode of transit is succeeded by another, the railways killed canals, as motor traffic is killing the railways. It is hard on the discoverer and inventor to be working at a period of transition on a method of transit which has not

¹ p. 240.

² *Roy. Soc. Proc.* Vol. XXI, p. 267.

yet been recognised as moribund. His work, however good, perishes with its subject. The greatest tragedy in the history of discovery is the invention of a great improvement on some existing process, which process itself is then in a brief time completely replaced by some novel and wide-reaching development.

Closely allied to Galton's meteorological work was his association with the Kew Observatory. The Kew Observatory, constructed for George III's amusement, had been handed over by the Government at the suggestion of the Council of the British Association (1842) as a centre for testing scientific instruments, and it ultimately fell under the control of the Royal Society (1872). We have already seen that Galton was placed on the Managing Committee in 1858 as a result of the movement set going by him for the standardisation of sextants and other portable angle-instruments. On this Committee Galton made or strengthened several scientific friendships, notably those with Sir Edward Sabine, who largely influenced Galton's scientific career, with J. P. Gassiot¹, and with Warren De la Rue. Galton succeeded De la Rue as Chairman of the Kew Committee in 1889 and held that post till 1901, when the Committee ceased to exist as an independent body on the constitution of the National Physical Observatory. Sabine had made Kew a central magnetic observatory for the world. Galton busied himself mostly with apparatus for the testing and standardisation of instruments of all kinds. Sextants, thermometers, watches, telescopes, field-glasses, photographic lenses were all tested at Kew, and in many of these cases it was Galton on whom fell the chief responsibility for selecting the methods and instruments used in the tests. We have already referred to Galton's first proposal to test sextants² by heliostatic processes, i.e. by flashing light from the Observatory to distant fixed mirrors, which would reflect the light for angular measurement back to the Observatory. This method was discarded owing to its dependence on suitable weather; it was succeeded by a system of collimators. Next, an instrument for standardising thermometers devised by Galton with the aid of suggestions by De la Rue was made by Mr R. Munro, and set up at Kew in 1875. After two years service, which suggested certain modifications, the instrument and its method of use were described by Galton in a paper entitled: "Description of the Process of Verifying Thermometers at the Kew Observatory," read at the Royal Society, March 15, 1877³. The apparatus reveals Galton's characteristic ingenuity, but is of too specialised a nature to be described here⁴. In 1890 a pamphlet entitled: *Tests and Certificates of the Kew Observatory*.

¹ The Gassiot's are frequently mentioned in *L. G.'s Record*, as present on social occasions and as joining the Galtons when on travel.

² Even as late as 1889, if we exclude thermometers, sextants stood second only to Navy binoculars, 292 to 341, in the statistics of instruments tested at Kew. In 1912 over 1000 sextants a year were being examined.

³ *Proc. Roy. Soc.* Vol. xxvi, pp. 84-9, 1877. See also *Phil. Mag.* 1877, pp. 226-31.

⁴ In 1912 it was still in use at Kew and was familiarly called "The Galton." That it should have survived nearly forty years service is a strong testimonial to its inventor's instrumental thoroughness.

Issued by the Kew Committee of the Royal Society, was published. Galton includes it both in his list of memoirs and in the bound volumes of his papers, so that it was doubtless compiled by him. It gives information as to the history of the Observatory, the wide range of instruments tested by the staff, the nature of many of the tests and the charges for testing. The Committee¹ of which Galton was then Chairman was indeed a strong one, and the general progress made in thirty years very noteworthy.

But Galton was not only interested in the methods of testing, but also in the convenience of the building itself and of its environment. General Strachey coming out one day from the Observatory noticed that the Mid-Surrey Golf Club had established a green immediately in front of the Observatory, and thinking how the matter might develop held that some means must be taken to secure a protected area round the building. But the institution possessed no funds for such an expenditure; accordingly Francis Galton (1893) generously and quietly provided the money, between £300 and £400, for placing a fence enclosing about six acres of ground round the Observatory. Dr Chree, the Superintendent, writing to me in 1912, said:

“Sir Francis’ interests according to my recollections were more with instruments and their verification than with observational work. He usually professed to regard himself as a poor man of business and finance, but I think this was partly a pretence intended to form an excuse for leaving financial matters largely to General Strachey,—a very great friend of Sir Francis’—who liked to deal with matters of that kind...The Kew Committee used to meet once a month with a long vacation in summer—and generally Sir Francis got me to go up to Rutland Gate before each meeting and go through the business with him. His long experience of the Observatory rendered him so familiar with the work that he used to get along wonderfully well as Chairman, notwithstanding his deafness.”

An amusing anecdote may be told to illustrate Galton’s kindness of spirit. With the increase of the testing work the Royal Society officers decided that the then existing system of Kew Observatory accounts—which was of General Strachey’s arranging, somewhat primitive, and not requiring any special financial training in the Observatory officials—must be altered, and the Royal Society’s auditor proposed a scheme of the complexity naturally dear to the professional mind. General Strachey was much hurt and Galton said privately that something must be devised to soothe General Strachey. This proved easier than might have been anticipated, for the non-financially trained, on close scrutiny of the accounts, discerned that the Royal Society had been recovering income tax and inadvertently not paying it over to the Kew Committee! That Committee was accordingly able to extract a substantial sum from the Royal Society and General Strachey was thus led to feel he was a match for the financial experts of the Society!

One or two miscellaneous papers may be fitly touched on in this chapter because they illustrate either Galton’s instrumental ingenuity, or have more or less relation to the subjects here discussed. About 1877 Galton sent a letter to the *Field* newspaper suggesting a very simple speedometer for bicycles. This was a small sand-glass and all the rider had to do was to

¹ Abney, Grylls Adams, Creak, Carey Foster, Admiral Richards, the Earl of Rosse, Rücker, R. H. Scott, Generals Strachey and Walker, and W. T. L. Wharton.

count the number of strokes he made with the foot on one treadle, while the sand-glass run down. This provided the number of miles per hour at which he was moving. For example a sand-glass running out in 6 secs. is appropriate to a wheel of 2 ft. 9½ inches diameter, while one of 10 secs. corresponds to one of 4 ft. 8 inches diameter¹. I am not aware that these sand-glasses ever came into use; with the differential gearing of the modern cycle, and with the free-wheel, several modifications would be needful.

A last meteorological paper by Galton was read at the British Association meeting 1880². It is entitled: "On determining the heights and distances of clouds by their reflexions in a low pond of water and in a mercurial horizon."

"The calm surface of a sheet of water," Galton writes, "may be made to serve the purpose of a huge mirror in a gigantic vertical range-finder, whereby a sufficiently large parallax may be obtained for the effective measurement of clouds. The observation of the heights and thicknesses of the different strata of clouds, and of their rates of movement, is at the present time perhaps the most promising, as it is the least explored branch of meteorology. As there are comparatively few places in England where the two conditions are found of a pool of water well screened from wind, and a station situated many feet in height above it, the author hopes by the publication of this memoir to induce some qualified persons who have access to favourable stations to interest themselves in the subject, and to make observations."

The observations were to be made with a sextant and mercurial horizon, and demand a knowledge of, or a discovery of, the following quantities:

(a) the difference of level between the surfaces of the mercury and of the pool (d);

(b) the angle between the reflection of a part of the cloud in the mercury and in the pool ($p_1 = n$ minutes of angle, say);

(c) the angle between the portion of the cloud and its reflection in the mercury (2α , Galton identifies α with the altitude of the cloud and suggests that it may be measured directly by a pocket altazimuth: see our p. 50).

Galton gives the approximation:

$$\text{Vertical height of cloud} = \frac{d}{n} 6875.5 \cos(\alpha + p) \sin \alpha$$

and tabulates the factor by which d/n must be multiplied for various values of $\alpha + p$ and p , or n , to obtain this vertical height. He mounted his horizon on a bar attached to a camera tripod, so that the reflection from the pool was seen *under* the mercury³.

In this chapter of Galton's life I have endeavoured to indicate the chief scope of his activities during the ten years which followed his South African travels and his marriage. On his return home he came into touch with men like Sir Edward Sabine and Sir Roderick Murchison whose enthusiastic spirit caused Galton's labours to be directed in their own specialised directions, and the impulses thus given led to phases of study the ramifications

¹ Only those who remember the cycles of the 'seventies will appreciate this diameter.

² *Report*, pp. 459-61.

³ I have checked Galton's formula of which he gives no proof on the assumption that the observer may be assumed to have his eye at the mercury, but I have had no opportunity of testing whether the method is fairly easy of application. Pools and cliffs are innumerable, but few of them are associated. The ideal spot would be a disused and flooded quarry.

of which lasted through many years of a long life. But Galton, while he maintained a keen interest in these topics, at least till 1900, grew less and less actively productive. A new and wider aspect of the cosmos was opening up for him, and evidence of an entirely different intellectual influence becomes apparent even in the 'sixties. His thoughts had begun to turn from the study of physical environment to the study of the organic contents of that environment, or in a narrower sense from cosmography to biology—from geography and meteorology to anthropology and psychology. There can be little doubt that the incentive in these directions came from his growing friendship with Charles Darwin, and the appearance of Herbert Spencer and Huxley in the circle of his acquaintances.

F. SPIRITUALISM AND JOURNALISM

I have attempted in this chapter to give a more or less complete account of those labours of Galton which deal with the physical and the mechanical rather than the human side of his studies. In case some of my readers may have found this account tedious, for not everyone can have understanding and sympathy for the catholicism of Galton's pursuit of knowledge, I will conclude this chapter with brief accounts of two other matters of more general interest, which occupied a good deal of Galton's time in the period under discussion. The man of science, who with the history of the world before him finds it impossible to accept a primitive folk's account of man's creation and its purpose, is tempted to consider whether the methods in which he puts his trust for solving problems of the phenomenal universe may not be adequate as instruments of research in the unknown vast of the hyper-phenomenal¹. Such a man of science, possibly owing to a lack of epistemological study, forgets that his senses have been developed to grasp physical phenomena, that his concepts are deductions from his sensuous perceptions, and that neither his sensuous nor mental outfits are adapted for sensating, perceiving and conceptualising the hyper-phenomenal. Some men grasp this truth by the logic of reasoning, others by the logic of experience, others by a healthy instinctive appreciation, and some never grasp it at all. To the first group we may, perhaps, say Huxley belonged, to the second Galton, to the third Darwin, and to the fourth Crookes and Alfred Russel Wallace.

Galton at any rate thought in 1872 that that branch of the 'supernatural' which we term spiritualism was at least worthy of inquiry. He endeavoured in a series of letters to interest Charles Darwin in his inquiries, and the latter appears to have been willing to give the matter a trial, but I have not been able to trace his letters; one at any rate went to Crookes, and another to Home, but in a letter of Darwin's son George to Galton there is a report of his father's incredulity as to the doings of Miss F.² It seems clear from the letters that Home had no great inclination to exhibit his powers to

¹ The good word 'supernatural' has become vulgarised until it signifies little more than something of which the user has inadequate previous experience occurring as a phenomenon, i.e. in the 'natural' world.

² See above, p. 53.

Darwin and Galton alone. It is probable that this reluctance led Galton to a less agnostic attitude towards spiritualism. If there were any other experiences which led to his final rejection of spiritualist claims, I have not found traces of them in his correspondence. It is possible that he became acquainted with Robert Browning's poem, *Mr Sludge, "The Medium,"* and he would be certain to read Huxley's report to Darwin on the trickery of another medium. The letters and paragraphs in letters to Charles Darwin on this subject are as follows:

5 Bertie Terrace, Leamington. March 28, '72.

MY DEAR DARWIN I enclose the revised statement about the curious trick¹ in Dr X's family. I questioned his widow only a fortnight before her death, all his 7 children, his son's wife and her 2 nurses. There is no contradictory evidence whatever.

Now about Mr Crookes, I have been twice at his house in séance with Miss F. who puts her powers as a friend entirely at his disposal, and once at a noisy but curious séance at Sergeant Cox's. I can only say, as yet, that I am utterly confounded with the results, and am very disinclined to discredit them. Crookes is working deliberately and well. There is not the slightest excitement during the sittings, but they are conducted in a chatty easy way; and though a large part of what occurs might be done, *if the medium were free*, yet I don't see how it can be done when they are held hand and foot as is the case. I shall go on with the matter as far as I can, but I see it is no use to try to enquire thoroughly unless you have (as Crookes says) complete possession of a first class medium. The whole rubbish of spiritualism seems to me to stand and fall together. All orders are given by raps,—levitation, luminous appearances, hands, writings and the like are all part of one complete system.

The following is confidential at present. What will interest you very much, is that Crookes has needles (of some material not yet divulged) which he hangs *in vacuo* in little bulbs of glass. When the finger is *approached* the needle moves, sometimes (?) by attraction, sometimes by repulsion. It is not affected at all when the operator is jaded but it moves most rapidly when he is bright, and warm and comfortable, after dinner. Now different people have different power over the needle and Miss F. has extraordinary power. I moved it myself and saw Crookes move it, but I did not see Miss F. (*even* the warmth of the hand cannot radiate through glass). Crookes believes he has hold of quite a grand discovery and told me and showed me what I have described quite confidentially, but I asked him if I might say something about it to you and he gave permission².

I can't write at length to describe more particularly the extraordinary things of my last séance on Monday. I had hold in one of my hands of *both* hands of Miss F.'s companion who also rested *both* her feet on my instep and Crookes had equally firm possession of Miss F. The other people present were his wife and her mother and all hands were joined. Yet paper went skimming in the dark about the room and after the word 'Listen' was rapped out the pencil was heard (in the complete darkness) to be writing at a furious rate under the table, between Crookes and his wife and when that was over and we were told (rapped) to light up, the paper was written over—all the side of a bit of *marked* note paper (marked for the occasion and therefore known to be blank when we began) with very respectable platitudes—rather above the level of Martin Tupper's compositions and signed "Benjamin Franklin"³! The absurdity on

¹ An hereditary habit of rather violently stroking the nose, while asleep, so that the thumb-nail occasionally lacerated that organ. I have just ascertained that it has been transmitted to a generation born since 1872.

² It is not clear from this passage how far either Crookes or Galton originally associated Crookes' radiometer with mediumistic powers.

³ As to Franklin:

“.....yourself
Explained the case so well last Sunday, sir,
When we had summoned Franklin to clear up
A point about those shares i' the telegraph:”

Mr Sludge, "The Medium," R. Browning's Works, Vol. VII, p. 183, 1889.
Sludge was Home, and Browning although, unlike Galton, he was able to convict him of fraud

the one hand and the extraordinary character of the thing on the other, quite staggers me; wondering what I shall yet see and learn I remain at present quite passive with my eyes and ears open. Very sincerely yours, FRANCIS GALTON.

5 Bertie Terrace, Leamington. *March 31st, '72.*

MY DEAR DARWIN Your letter will be a great encouragement to Crookes and I have forwarded it to him to read, telling him what I had written.

About the 'female'—I hesitated a full 10 minutes before inserting the word 'it' on the ground that the subject of the story might be identified in after life and that the knowledge of the trick might damage her marrying value! I do not know if I am over fastidious. It is purely my own idea—no objection was raised by any of the family. So do entirely as you like¹. Very sincerely yours, FRANCIS GALTON.

42 Rutland Gate. *April 19/72.*

MY DEAR DARWIN I have only had one séance since I wrote, but that was with Home in full gas-light. The playing of the accordion, held by *its base* by one hand under the table and again, away from the table and behind the chair was extraordinary. The playing was remarkably good and sweet². It played in Sergeant Cox's hands, but not in mine, although it shoved itself, or was shoved under the table, into them. There were other things nearly as extraordinary. What surprises me, is the perfect apparent openness of Miss F. and Home. They let you do whatever you like, within certain reasonable limits, their limits not interfering with adequate investigation. I really believe the truth of what they allege, that people who come as men of science are usually so disagreeable, opinionated and obstructive and have so little patience, that the séances rarely succeed with them. It is curious to observe the entire absence of excitement or tension about people at a séance. Familiarity has bred contempt of the strange things witnessed, and the people find it as pleasant a way of passing an idle evening, by sitting round a table and wondering what will turn up, as in any other way. Crookes, I am sure, so far as it is just for me to give an opinion, is thoroughly scientific in his procedure. I am convinced, the affair is no matter of vulgar legerdemain and believe it well worth going into, on the understanding that a *first rate medium* (and I hear there are only 3 such) puts himself at your disposal.

Now considering that the evenings involve no strain, but are *a repose*, like the smallest of occasional gossip; considering that there is much possibility of the affair being in many strange respects true; considering that Home will, *bonâ fide*, put himself at our disposal for a sufficient time (I assume this from Crookes' letter and believe it, because it would be bad for Home's reputation, if after offering he drew back; but of course this must be made clear); considering,

(Griffin and Minchen, *Life of Robert Browning*, p. 203, 1910) only did so publicly in this poem, which so strangely echoes Galton's account of the séances.

¹ This last paragraph refers to an entry in the pedigree of the nose-stroking family.

² So Browning again:

"All was not cheating, sir, I'm positive
I don't know if I move your hand sometimes
When the spontaneous writing spreads so far,
If my knee lifts the table all that height,
Why the inkstand don't fall off the desk a-tilt,
Why the accordion plays a prettier waltz
Than I can pick out on the piano-forte,
Why I speak so much more than I intend
Describe so many things I never saw.
I tell you, sir, in one sense I believe
Nothing at all,—that everybody can,
Will, and does cheat; but in another sense
I'm ready to believe my very self—
That every cheat's inspired, and every lie
Quick with a germ of truth."

Mr Sludge, "The Medium," loc. cit. p. 236.

I say, all these things, will you go in for it, and allow me to join? Home is a restless man, as regards his movements, and could be induced to go to and fro. I am sure I could—if I could ensure a dozen séances, at which only our two selves and Home were together. (Others might be in the room, if you liked, but, I would say, not present within reach.)

It is impossible, I see, to prearrange experiments. One must take what comes, and seize upon momentary means of checking results. Home encourages going under the table and peering everywhere (I did so and held his feet while the table moved), so I am sure you need not feel like a spectator in the boxes while a conjuror is performing on the stage. He and Miss F. just want civil treatment and a show of interest. Of course, while one is civil and obliging, it is perfectly easy to be wary. Pray tell me what you think of the proposal in Crookes' letter. Very sincerely yours, F. GALTON.

42 Rutland Gate, S.W. May 26, '72.

MY DEAR DARWIN I feel perfectly ashamed to apply again to you in my recurring rabbit difficulty¹, which is this: I have (after some losses) got 3 does and a buck of the stock you so kindly took charge of cross-circulated, and so have means of protracting the experiments to another generation of breeding from them and seeing if their young show any signs of mongrelism. They do not thrive over well in London, also we could not keep them during summer at our house, because the servants in charge when we leave could not be troubled with them. Is it possible that any of your men could take charge of them and let them breed, seeing if the young show any colour, then killing the litter and breeding afresh, 2 or 3 times over? I would most gladly pay even a large sum—many times the cost of their maintenance—to any man who would really attend to them. Can you help me?

As regards spiritualism nothing new that I have seen since I wrote, for Home and Miss F. have been both absent. I wrote a letter of overtures to Home when I enclosed yours, but got no reply. I have kept up communication with Crookes, and am satisfied that he has the investigation thoroughly in hand, and delays publication on grounds of desiring a little more completeness of data. He is a most industrious taker of notes.

How very kind your letter was about Home. It grieved me much that you had to speak in such terms about your health. Ever sincerely yours, FRANCIS GALTON.

Three days later, to a letter arranging to lunch at Down, Galton adds the postscript: "The spiritualists have given me up, I fear. I can't get another invite to a séance." Darwin evidently wrote about this time to Galton asking the latter to introduce a friend to the spiritualistic fraternity, for on June 7, 1872, Galton writes from Rutland Gate:

MY DEAR DARWIN I did not reply yesterday about the Spiritualists as I expected that day and this to have heard from Mr Home, and Crookes is out of Town. It will give me great pleasure to do what I can for X.Y. but I rather doubt whether I shall have power to do much. I can't myself get to these séances as often as I like—indeed I have had no opportunity for a long time past. The fact is, that first class mediums are very few in number and are always acting. Also that Crookes and others are working their very best at the subject and entertain a full belief that they will be able to establish something important and lastly what, I see, is a real difficulty with them, the introduction of a stranger always disturbs the séances. I say all this to excuse me in your eyes, if I don't fulfil your wishes as you would like; but I will do my best and write—whenever I have anything to say to X.Y. as you propose.

The person most likely to help would, I think, be Lord L.

I wonder if I have offended Home by my last letter to him—he has never replied and I hear incidentally there is to be an important séance this very night! Alas for me! Ever yours sincerely, FRANCIS GALTON.

The last letter to Darwin concerning Home was in November of 1872. In the concluding paragraph of a further communication regarding the nose-stroking family Galton writes:

¹ This refers to a continuation of the 'Pangenesis' experiments after the publication of the memoir of 1871 to be discussed later.

"Crookes wrote to me that Home's presence was very important, for the experiments were far more successful when he was the medium, than when anyone else was, and he is now in Russia and will not return until May. So I will wait."

One almost imagines that Home fled¹ before the courteous manner but scrutinising eye of Galton! Our truthseeker did not immediately give up the pursuit of the hyper-phenomenal. In February of the following year (1873) there is a letter to Huggins about the psychology of the latter's dog 'Kepler²', and it ends with a few remarks on a suggestion of Huggins' that a medium who untied himself in a room—presumably through spirit assistance—should be watched through an aperture. Galton fears the room would be too dark, but says that he will suggest to Crookes that previous experiment be made to see if it is.

Certain letters given in Francis Darwin's *Life of Charles Darwin*, Vol. III, p. 187, probably indicate the end of Darwin's and Galton's inquiries into spiritualism.

"Spiritualism was making a great stir at this time. During a visit to Erasmus Darwin's in January 1874, a *séance* was arranged with Mr X., a paid medium, to conduct it. We were a largish party sitting round a dining-table, including Mr and Mrs G. H. Lewes (George Eliot). Mr Lewes, I remember, was troublesome and inclined to make jokes and not play the game fairly and sit in the dark in silence. The usual manifestations occurred, sparks, wind blowing, and some rappings and movings of furniture. Spiritualism made but little effect on my mother's mind [Mrs Charles Darwin] and she maintained an attitude of neither belief nor unbelief." *A Century of Family Letters*, 1904, Vol. II, p. 269.

Darwin himself wrote [Jan. 18, 1874] about this *séance* :

"We had great fun, one afternoon, for George hired a medium, who made the chairs, a flute, a bell, and candlestick, and fiery points jump about in my brother's dining-room, in a manner that astounded everyone, and took away all their breaths. It was in the dark, but George and Hensleigh Wedgwood held the medium's hands and feet on both sides all the time. I found it so hot and tiring that I went away before all these astounding miracles, or jugglery, took place. How the man could possibly do what was done passes my understanding. I came downstairs and saw all the chairs, etc., on the table, which had been lifted over the heads of those sitting

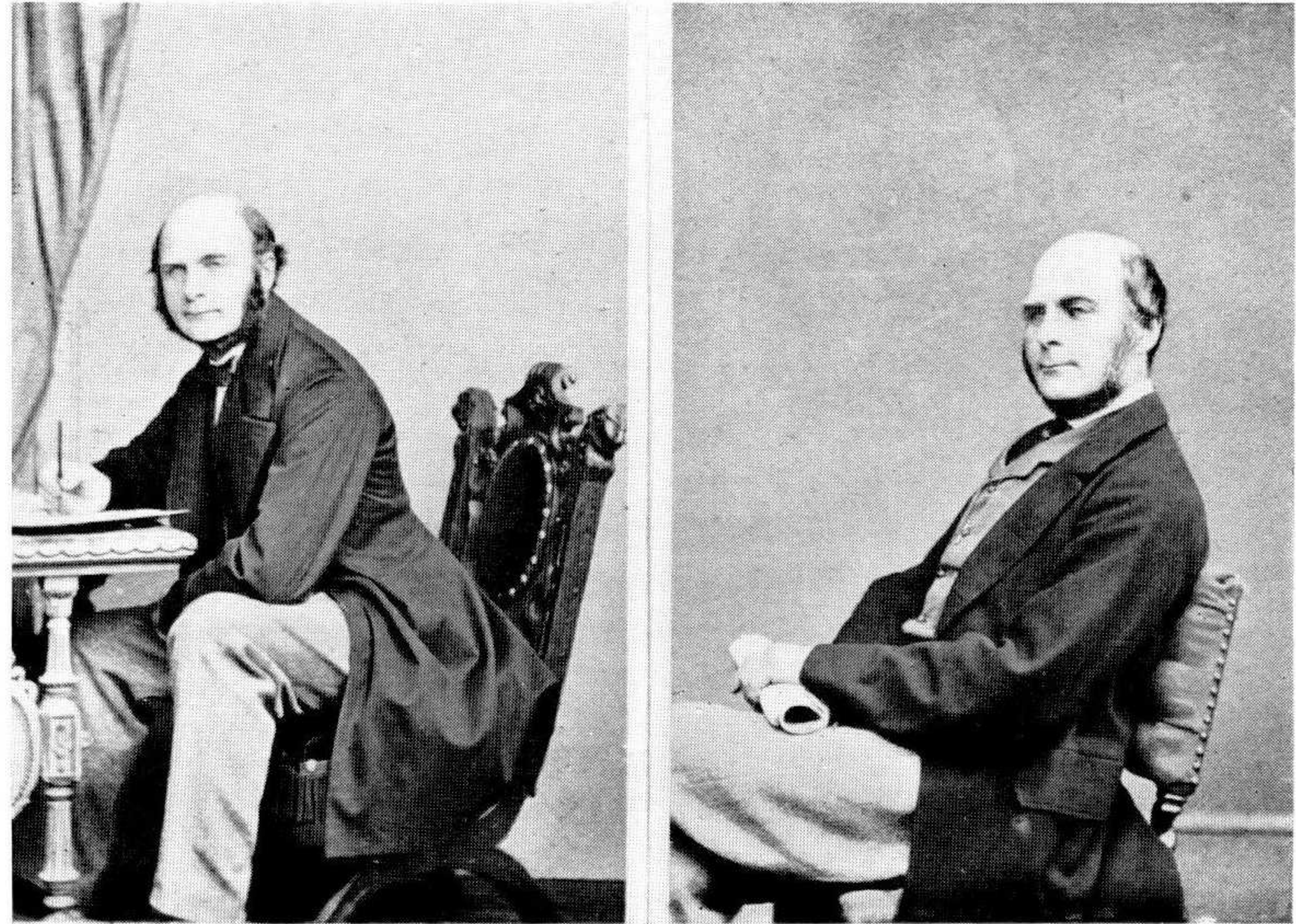
¹ As Browning puts it :

"What? If I told you all about the tricks?
Upon my soul—the whole truth and nought else,
And how there's been some falsehood—for your part,
Will you engage to pay my passage out,
And hold your tongue until I'm safe on board?
..... Begin elsewhere anew!
Boston's a hole, the herring-pond is wide,
V-notes are something, liberty still more,
Beside, is he the only fool in the world?"

Mr Sludge, "*The Medium*," *loc. cit.* pp. 184, 245. Browning's contact with Home appears to have been in 1857 or 1858. Sutherland Orr, *Life and Letters of R. Browning*, p. 216, 1891. *Dramatis personae* containing *Mr Sludge*, "*The Medium*" dates from 1864. The Galton-Darwin letters from 1872. Did Galton chance to read Browning? Home's habit of slipping across the 'herring-pond' when the environment was growing difficult for him seems to have been characteristic.

² 'Kepler' was one of a family of dogs that feared a butcher's shop and were furious at butchers. Galton writes "What you say about dogs' reasoning reminds me of a phrase used by the master of some performing dogs: 'Dogs, sir, do a deal of *pondering*'." See *Nature*, Vol. VII, p. 281, 1873.

PLATE IX



Francis Galton, aged 42, from photographs of 1864.
Co-editor with Herbert Spencer and Norman Lockyer of *The Reader*.

round it. The Lord have mercy on us all, if we have to believe in such rubbish. F. Galton was there, and says it was a good *séance*.....

Such as it was it led to a second smaller and more carefully organised one with Huxley present, who reported to Darwin."

That report is printed in Huxley's *Life and Letters*, Vol. II, pp. 144-9. His conclusion was that the medium was "a cheat and an impostor." It produced the following letter from Darwin :

DOWN, *January 29* [1874]

MY DEAR HUXLEY.—It was very good of you to write so long an account. Though the *séance* did tire you so much it was, I think, really worth the exertion, as the same sort of things are done at all the *séances*, even at ——'s; and now to my mind an enormous weight of evidence would be requisite to make one believe in anything beyond mere trickery....I am pleased to think that I declared to all my family, the day before yesterday, that the more I thought of all that I had heard happened at Queen Anne St, the more convinced I was it was all imposture....My theory was that [the medium] managed to get the two men on each side of him to hold each other's hands instead of his, and that he was thus free to perform his antics. I am very glad that I issued my ukase to you to attend.

Yours affectionately, CHARLES DARWIN.

Probably Galton also saw Huxley's report and concurred in his judgment. At any rate he very soon became a despiser of 'spiritualistic' *séances*.

Such are the last traces I can find of Galton's investigations into spiritualism. Some thirty-five years later Galton knew that the present writer had been invited to attend a *séance* by one who had sought aid from spiritualism in what formed for different reasons a crisis in the lives of all three. From his few written words on that occasion I know that Galton must long and definitely have been convinced of the futility of any light reaching human affairs from that strange medley of self-deception, chicanery and credulity which passes under the name of spiritualism. But I have no clue to the events or mental processes by which his attitude passed from the stage of agnosticism to that of complete rejection.

I have already indicated elsewhere that Galton was young till his death. Even between forty and fifty he was a boy who must try his powers on all things that came his way; it is true that he had had for some years experience of editing the Royal Geographical Society's *Journal*, but in 1865, amid all his other projects and work, Galton took upon his shoulders a very considerable share of the editorial duties of a weekly journal—*The Reader*. Galton himself says it was an amusing experience, and indicates that the loss of the guaranteed £100 was more than compensated by the gain of an unexpected view of the seamy side of journalistic enterprise¹. The attempt was a brave one, and one of the committee of three, Spencer, Galton and Lockyer, which was appointed to make the preliminary arrangements, very shortly after made a marked success with a somewhat similar journal—*Nature*.

The Reader had been established in January 1863 as a journal of Literature, Science and Art, and when purchased towards the end of 1864, the programme of its future aims was propounded as follows:

"The very inadequate manner in which the progress of Science and the labour and opinions

¹ *Memories*, pp. 167-8.

of our scientific men have been recorded in the weekly press, and the want of a weekly organ which would afford scientific men a means of communication between themselves and with the public, have been long felt."

The aim of *The Reader*, without neglecting Literature, Art, Music and the Drama, was to supply this need. The prospectus then goes on to say that "the scientific arrangements of *The Reader* have the support and approval of"—and then follow 75 names, which cover practically all the men who created mid-Victorian science: Darwin, Galton, Grove, Hooker, Huxley, Lubbock, Lyell, Murchison, Sabine, Spottiswoode, Tyndall and Wallace; Adams, Balfour Stewart, Cayley, Crookes, De la Rue, Frankland, Glaisher, Hind, Hirst, Hofmann, Maskelyne, Odling, Roscoe, Stokes, Tait, William Thomson (Lord Kelvin) and Williamson; Babington, G. Bentham, G. Busk, John Evans, W. H. Flower, Andrew Ramsay, Sclater, Sharpey and Woodward, with many other names familiar enough to the scientific world of the third quarter of the nineteenth century. It was a tremendous force to bring together, and, all because there was no one man who would devote his whole life and whole energy to the projected task, *The Reader* came to nought.

The original shareholders in the company were G. Burges, J. E. Cairns, Rev. Ll. Davies, Galton, Gassiot, Huth, T. Hughes, Huxley, Lubbock, Lockyer, Robins, Roget, Spottiswoode, Spencer and Tyndall!

The first meeting was held in the rooms of Tom Hughes¹ in Lincoln's Inn Fields on Nov. 15, 1864, and the rough notes of the proceedings are in Galton's handwriting. £2250 were to be paid for the paper, plant and lease. Cairns was to take charge of the Political Economy, Galton of Travel and Ethnology, Huxley of Biology, Lewes of Fiction and Poetry, Spencer and Bowen of Philosophy, Psychology and Theology, while Seeley was to be asked to take charge of Classics and Philology. There were to be ten pages of Literature, three of Miscellanea, eight of Science, two of Art, and two of Music and the Drama. Four thousand copies were to be printed at a weekly cost of £110 including printing, paper, publication and office expenses. The returns were modestly estimated at sales 2000 copies £25 and advertisements £65, so that an initial loss weekly of £20 was anticipated. It made a brave show on paper—Tom Hughes' familiar legal blue 'opinion' paper—but the outcome was a little different. Herbert Spencer wasted the time of the committee in discussing 'first principles'; the powerful scientific support failed when it was pressed for reviews and articles, the paid sub-editor, the only man with 'real journalistic experience,' rather got on the nerves of the managing committee through his methods of procuring advertisements. Learned but illegible contributors sternly remonstrated with the editors about the inadequate and imaginative efforts of the proof-readers. The reviewers knew in some cases more of the subject than the authors of the books reviewed, and as a consequence the latter wrote long and angry letters to *The Reader*. Notably Burton, within a few months of Speke's death, replying to a review of his own *Nile Basin*, presumably by Galton, sent a truculent letter carrying on *post-mortem* hostilities. The critic, Burton tells us, ought to have known that his theory was one of the

¹ The author of *Tom Brown's Schooldays*.

most ridiculous ever put forth by man and was cobbled up in the map-room of the Royal Geographical Society. It would have its merit in the eyes of those who collect "romantic geography." A friend of Speke might wonder whether publication or non-publication was the wiser course. Poor Galton, endeavouring to still the fight and be fair to *both* men, had indeed his Scylla and Charybdis to steer between! The trials of an editor are manifold, but the trials of an editorial committee must be computed by multiplication not by division. The ship had too many first rank commodores aboard, and no one whose livelihood depended on a successful voyage. It is small wonder that it never reached port. *Pereat Lector, Natura resurgat*¹.

Many years later Galton was again an editor. In 1901 he consented to be "Consulting Editor" of *Biometrika*, a post, I think, he appreciated² though the acting editors did not trouble him much. The 'pink sheets' with résumés of the conclusions reached in the papers of each part, which were features of the earlier volumes, were undertaken at his suggestion³.

The contents of this chapter will probably lead the reader to think we must have exhausted Galton's activities and labours during the twenty years that followed his marriage; on the contrary we have hardly considered a moiety of them, and those which remain to be discussed are of the greater importance.

¹ The *Reader* expired in 1866; *Nature* with an almost identical science programme appeared in November 1869, with Norman Lockyer as sole editor. But the introduction was by Huxley ("half a century hence curious readers will probably look at our *best*, not without a smile"), and Galton, Wallace, Darwin, G. H. Lewes, Sir William Thomson, Tylor, Balfour Stewart, Roscoe, etc., all the crew of the old *Reader* manned the new vessel and helped to steer its course into smooth waters.

² He inserts it as an item in his list of memoirs (*Memories*, p. 330), and included it in a privately printed list of "Biographical Events."

³ Galton's journalistic suggestions were often of surprising originality when they were made, but will now seem commonplaces. Thus his idea of weather charts in the daily press, unthought of when he made it (1868); the idea that foreign and *colonial* books especially were not, but ought to be, adequately noticed in the English press; that new maps ought to be reviewed and criticised; that as to "Blue Books, no notices of them were published except in a list at the beginning and end of the session or very rarely at other times although 50 volumes appeared a year, but they ought to be continually reviewed"; that a list of new publications ought to be issued weekly under a suitable classification (1864, I cite from Galton's suggestions for *The Reader*); these ideas were practically novelties when Galton propounded them. Like forks and brooms they are such commonplaces of our traditional culture to-day, that not one person in a hundred feels any gratitude to the unknown originator.