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Source: *The Geographical Journal*, Vol. 57, No. 5 (May, 1921), pp. 336-348

Published by: geographicalj

Stable URL: <http://www.jstor.org/stable/1780841>

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The spelling of the name Erickson is that given by the son of the old trader and hunter who travelled extensively in Ovamboland and southern Angola years ago, and whose name figures frequently on maps of these parts. The son, who is personally known to the present British Resident Commissioner for Ovamboland, informed the latter that his father claimed to be British.

The origin of the names Rua Cana and Serra Cana is not known, but is probably a Portuguese corruption of an old native name. The Ovashimba recognize the name Rua Cana, but have probably learnt it from Portuguese sources.

The description of the bluff or escarpment at the great falls as the "Serra" Cana or Cana Range is most misleading, as it is really no range of hills at all. The term was, however, used in the German-Portuguese treaty of 1886 and in all subsequent official correspondence and has therefore been retained. The Germans called the country between the Angola boundary and the Etosha Pan "Amboland," but I think this term is incorrect. It is locally unknown. It is the country inhabited by the very distinct Bantu tribe of the Ovambo, and is known officially, both to the Portuguese and South African Union Governments, as "Ovamboland," and the term Amboland should no longer be used.

INTERNATIONAL AERONAUTICAL MAPS

Lieut.-Col. E. F. W. Lees, D.S.O.

*Read at the Meeting of the Society, 17 January 1921. Maps following
p. 400.*

THE subject of an International Aeronautical Map was first discussed some nine years ago, when, in September 1911, Monsieur Lallemand read before the British Association at Portsmouth a paper entitled "The International Air Map and Aeronautical Marks." His opening sentence was, "The dirigible air balloon, and more especially the aeroplane, which are to-day scarcely out of the period of research and experiment, will soon enter the area of practical politics. It is time that aviators were given means for finding their way similar to those which, for a long time, have existed for navigators and travellers." No definite progress towards the establishment of International Air Maps had, however, been made when the war broke out, and during the war the question was naturally in abeyance; various types of special maps, adapted for the uses of airmen, were published by different nations, but these maps were in no sense international.

Within a year after the armistice, in October 1919, a convention was signed in Paris by some thirty nations and states. This convention laid down the regulations for aerial navigation, and, in an annex, recognized the need for an international series of aeronautical maps, and established certain general principles. These principles embody certain of the proposals which M. Lallemand put forward in 1911.

In this annex it is laid down that there shall be two series of international air maps: one series, to be known as General Aeronautical Maps, is to be on Mercator's Projection, on a scale of 3 cm. to 1 degree

of longitude at the equator, *i.e.* a scale of about 1 : 3,700,000 at the equator, a longitudinal scale of about 1 : 2,000,000 in our latitudes. Certain criticisms have been levelled at the adoption of Mercator's Projection; these will be referred to later.

The second series, to be known as Local Aeronautical Maps, is to consist of degree sheets on a scale of 1 : 200,000; no particular projection is laid down, nor is this necessary. In many countries maps exist already on a scale of 1 : 200,000, and no doubt these maps will be utilized; it must be remembered, however, that in their existing forms they satisfy only imperfectly the needs of the airman.

The annex lays down also :

- (i.) that the index scheme for the Aeronautical Maps shall be based on the index scheme for the International 1/Million Map;
- (ii.) that the metre shall be the standard of length;
- (iii.) that the colours and symbols of the 1/Million series shall be used as far as possible: it will be seen that considerable departures from this proposal are suggested;
- (iv.) that, in addition to the customary latitude and longitude notations, the maps shall bear numbers in enclosed rectangles corresponding to a new system of co-ordinate reckoning based on the South Pole and the antimeridian of Greenwich: that is to say, the latitudes commence with the South Pole as zero, and increase northwards to 180° at the North Pole, and the longitude commence with the present 180° as zero and run eastwards round the sphere to 359°. By this system the employment of the letters N. and S. and E. and W. is avoided, and an index number can be given to any sheet based on the co-ordinates of its south-west corner. It should be noted that, under this system of indexing, certain general and local maps will bear the same index number, and that it will therefore be necessary to employ the prefix General or Local when demanding aeronautical maps;
- (v.) that each sheet is to be given a suitable geographical name.

The annex finally gives a summary of the details which are to be shown on the sheets of each series, and establishes certain conventional signs. These signs have not in all cases proved entirely satisfactory, and alterations are suggested. Additions have also been made: no symbol, for instance, was laid down for a seaplane station.

The work involved is immense, and a considerable proportion falls on the shoulders of the British Empire. The Air Ministry were faced with the problem of compiling and producing these maps, with no existing machinery. The problem was solved by an arrangement between the War Office and the Air Ministry, whereby the Geographical Section of the General Staff should undertake the work. This arrangement came into force in April last.

The first work undertaken was the preparation of an index scheme for the general maps. At this point the adoption of Mercator's Projection began to come in for some criticism. Mercator's Projection has always been used for navigation on account of the property that the compass course between any two points is the straight line joining them. The drawbacks are the varying scale, the great distortion towards the Poles (so much so that, for maps of the Polar Regions, it will be necessary to employ some other projection), and the considerable additional expenditure in time and labour in production, owing to the necessity for redrawing the map. One proposal, based chiefly upon the large part which radiogoniometry (directional wireless) will play in navigation, was that a gnomonic projection should be employed: the Great Circle Bearings obtained by radiogoniometry can then be plotted as straight lines. The formula for the conversion of the Great Circle Bearing to the Loxodrome is, however, so simple that the proposal, in view of other drawbacks, did not gain adherents. Another proposal was to employ a modified polyconic projection with rectilinear meridians. This would mean economy in time and labour, as the existing Million Series could be used direct: the scale would be the same on all sheets, facilitating the measurement of distances. But navigation on such a projection involves an appreciable change of direction for the aviator at each meridian: this change will be about $\frac{1}{2}^\circ$ to 1° for 1° of longitude. Navigators, however, strongly upheld the proposal to adopt Mercator's Projection for the general maps, and an index was prepared utilizing this projection. The index is based on the index for the International Million Series. Between 60° S. and 60° N. according to the old notation, or between 30° and 150° according to the new notation, each sheet of the General Aeronautical Series will be 18° by 12° and will contain nine sheets of the Million Series: between 150° and 158° each sheet will be 18° by 8° and will contain 6 sheets of the Million Series. The distortion then becomes very great, and it would appear that north of 158° and south of 30° we should adopt some other projection. Though it may be considered advisable to carry the Mercator Series as far north as 162° in order to include Northern Scandinavia, Northern Canada, etc., the General sheets between 158° and 162° would only contain three sheets of the Million Series. The British Empire will be responsible for the production of thirty-six sheets.

One other point arises in connection with this index scheme, and that is the question of overlap. The value of an overlap for aerial navigation is recognized, and a proposal was put forward that there should be an overlap of 3° both in latitude and longitude. This appeared excessive; some sheets would become unwieldy, and the cost of production of a sheet would be considerably increased, and it has now been agreed that an overlap of 1° of latitude and 2° of longitude, wherever the sheet edge is not in the sea, will meet the needs of the airman.

The question of the design of these aeronautical maps was next taken

up. We are on the threshold of a wide development of cartography for aerial purposes, and it appears desirable that we should endeavour to lay down a basic scheme which shall be logical, feasible, and applicable to all aerial maps, the general map, the local map, and any special maps prepared for aerial purposes. The proposals which are about to be submitted to you have met with general approval, except in one or two particulars, in their application to the local maps, but in their application to the general maps considerable differences have arisen, based on the uses to which these general maps are to be put. One point of view is that the general and local maps are entirely different in purpose, the general maps being for navigation, the local maps to enable the aviator to fix his position by comparing the ground beneath him with his map. The other point of view is that the two series are complementary to each other. The depiction of relief is the question chiefly affected, and this difference of opinion will therefore be dealt with in detail when that question is arrived at.

Terrestrial man has, under normal circumstances, a limited view compared with that obtained by the airman, and his gaze is horizontal. A picture will not be of very great assistance; he wants a great deal of information given him in the way of names, etc.; he has milestones, sign-posts, and his own tongue to help him. The aviator is differently situated: he has a large area spread out beneath him, his view is more or less vertically downwards, and he is therefore materially aided by a picture: he does not require much in the way of names, but he does want the characteristic geographical features and all artificial features of special value as guides to stand out clearly. Shape is of special value to the airman: terrestrial man walking along a road, railway, or river which curves about a great deal, does not appreciate the relative values of the curves; the airman does—so much so that he can locate his position by these relative values. Our design must therefore be a logical one, controlled by the values which the aviator places upon the various objects seen from his machine.

The aerial map can scarcely show too much detail, provided there is no suspicion of overcrowding: the limitation of names renders this easier. The exact position and shape of railways, roads, rivers, towns, etc., must be shown as far as the scales employed will allow. On the local maps on a scale of 1 : 200,000 a large amount of detail can be shown, so much so that an airman, who gets in bad weather only a fleeting glimpse of the ground, should be able to locate himself. The scale of the general maps permits only a selection of the detail to be shown, and this selection must depend on the value which the airman places on objects as guides to his position or to course.

The conventional signs must also be based on this value. For instance, among the conventional signs laid down by the Convention is one for telegraph wires consisting of large red crosses: these will stand out in a

most conspicuous manner overshadowing other detail. Whereas in close country the airman will not see the telegraph lines, in open or arid country on a sunny day he may pick up the shadows of the posts, but these shadows will not dominate the landscape. Telegraph lines must be shown, in so far as this is possible without overcrowding the map, as such lines may afford a valuable indication of his whereabouts to the airman, but a conventional sign must be adopted which gives to a telegraph line its correct value from the airman's point of view with reference to the other objects depicted on the map.

Our object must therefore be to obtain a map which shall be clear, which shall be, as far as in our power, a fairly good picture, and which shall give to objects on the ground the value which the aviator places upon them.

For a picture a ground colour is necessary, and it is suggested that a pale green should be used for cultivated ground or ground covered with vegetation, a pale buff for arid ground : in addition to getting a base for the picture, valuable information is provided by this means in many parts of the Empire. To this proposal some objections have been raised. The first is that the ground tint varies according to the season of the year : it is agreed that this seasonal variation is difficult to cater for, but the areas in which a prevalent tint is difficult to arrive at are, taking the world as a whole, limited, and it should be possible to overcome this difficulty. Secondly, that the pencil lines used in plotting a course do not stand out as they would on a white ground : this objection was withdrawn after actually plotting a course on a manuscript map with ground colours. The third objection is that a layer system to indicate relief cannot be employed with a ground tint : this is agreed to, but the employment of a layer system is not advocated.

The maps being primarily aeronautical, we may take it that the provision of aeronautical information in a conspicuous form must be our first care. Black on a map is more conspicuous than any other colour ; it is also easier to disassociate black from colours than one colour from another. The aerial information will therefore be in black, and will include the positions of aerodromes, sea-plane stations, and ports of entry, the heights of mountains and passes, the positions of aerial and marine lighthouses, lightships, and wireless stations, and any natural or artificial features which are too small to be represented to scale on the map, but which may be of value to the airman.

Water, always a most useful guide to the airman, will be represented in the conventional blue, in the conventional way, except that swamps, etc., will be shown in blue stipple.

Having decided upon black for all aeronautical information, and blue for all water, the next most conspicuous colour, red, must be used for the objects upon which the airman places the next greatest value. It is considered that railways come next in the airman's picture : in France and

Italy it is said that the roads are of more value than the railways, but taking the world as a whole, this does not apply. Railways are not confusable with other objects, and they are accurately surveyed as regards shape, although their location may be faulty in badly mapped countries : accurate shape, and the accurate plotting of junctions, curves, etc., are invaluable to the airman as guides to his position. Railways go fairly directly from one town to another, having been built to serve the needs of those towns, and the towns they serve are the important towns of a country and therefore normally the objective of the airman both in peace and war : they can be followed both by day and by night in clear weather. In unsettled or sparsely populated countries railways are of the first importance : they afford not only a means of obtaining supplies of petrol, oil, and food, but a probability of obtaining assistance in the event of a forced landing.

Dealing with roads, to the airman roads of any class, first, second, or third, appear much the same. The earth is covered, in highly settled districts, by a reticulation like the workings on a hot-house melon. The main road may be conspicuous by reason of its directness, or as the backbone of a system of roads ; but all roads, when wet, muddy, or tarred, tend to merge into the landscape and lose their individuality : on a railway in use, in fine or wet weather, there is always the shine on the metals. In many parts of the world roads are anything but accurately surveyed.

It is proposed, therefore, to consider the railways as being of more importance to the airman than the roads, and to show them in red : on the general maps by a single red line ; on the local maps a single line of rail will be indicated by one red line, a double line by two red lines, three pairs of rails or more by the two lines blocked in. On the general map it will be possible to show practically all railway lines : if roads are adopted as being of more value to the airman than railways, only some roads and some railways can be shown, and an untrue picture is arrived at. As it is, one detail of the map, railways, is complete : such roads will be shown as the scale permits.

Towns and villages stand out well, and when, as in the local maps, it is possible to show their shape and main arteries, they are most useful guides : it is proposed to indicate them in red. Railways, towns, and villages being indicated in red, it appears sound to propose that all artificial structures, other than those which come under the heading "Aeronautical Information" (lighthouses, lightships, conspicuous guiding marks, etc.), or the heading "Waterways" (canals, etc.) shall be indicated in red : telegraph lines, light railways, tramways, electric power cables, etc., will therefore be shown in this colour.

Roads will be shown in a deep yellow or burnt sienna : if the latter colour is to be used, great care must be taken that it approximates in no way to red.

Woods will be in the conventional colour, green, but not too con-

spicuous a green, as the airman must not rely too much upon the exact outline of woods as an indication to his position. A map cannot be kept sufficiently up to date to show new clearings in, or additions to, woods: a young plantation may be just as conspicuous as a well-established wood.

To sum up, it is proposed to show, on a pale green or pale yellow ground: aeronautical information in black; water in blue; all artificial structures in red, except those which come under the headings "Aeronautical Information" or "Waterways"; roads in deep yellow or burnt sienna; woods in green. Criticism has been levelled at the proposed colours of railways and roads: the counter-proposals are to show the railways in black and the roads in red.

With regard to the railways it is claimed that they are so important to the airman that they should be treated as "aerial information" and indicated in black. None of the aerial information, to be shown on the map, takes the form of a long black line: moreover, black is the conventional colour laid down for the International Million Map. Railways in black have been tried: the result on the map was an immediate loss, in highly civilized countries, of that which we are striving to obtain—absolute clearness for the aeronautical information. As time goes on, there is no doubt that the maps will be heavily loaded with aerial information, especially in the shape of ground marks. At many railway stations the name will be painted on the roof: a railway in black will not show up among these ground marks in black, a railway in red will. It is agreed that the indication of the number of pairs of rails is of value to the airman: if black is employed, a long length of "three or more" pairs of rails will "kill" the neighbouring aerial information, a short length will approximate to the conventional sign for an aerodrome. With regard to the argument that the conventional colour is black, it is agreed that this is so on the majority of maps, but it appears to be most undesirable that we should be bound by convention. Maps exist at present for those who travel on land or sea; now a start is to be made on the maps for those who travel by air, and these maps must be based, not on the conventions, but on the requirements of the airman.

The proposal to show roads in red is based on convention, although, whereas railways are largely shown in black, many instances of roads in colours other than red can be adduced. Again, it is urged that convention should be put aside. It is also argued that roads are just as much artificial structures as railways. This is hardly correct: in very large areas of the Earth roads are artificial only in the sense that man has cleared away the tree-stumps or boulders. There is also this difficulty in connection with the indication of roads in red: it is generally agreed that towns and villages are to be in red, and that the main arteries of a town or village shall be shown. This cannot be done with roads in red: the indication of a village consisting of a single row of houses on either side of the road will be impossible. It has been suggested that this difficulty might be met by

leaving the roads white in the towns and villages, but the result would not be satisfactory in the case of long villages on either side of a road: the effect is that of a road splitting into two and joining up again. Red will give the roads too much importance in the picture, especially as the railways will have lost their distinctiveness owing to their being in the same colour as the aerial information. There are many maps which show the effect of accentuating the roads in red.

It is suggested, therefore, that the depiction of the railways in red and the roads in yellow or burnt sienna will enable us to more nearly satisfy the requirements of the airman than the proposal to show railways in black and roads in red.

There is still one question of great importance to be considered, and that is the question of the indication of the topographical relief. With regard to the Local Maps, there appears to be a general agreement that some form of hill shading shall be employed: this is in accordance with the Convention. With regard to the General Maps, there is no such general agreement: two camps have formed, one advocating the employment of a layer system, involving, of course, no use of ground tints, the other advocating the employment of hill shading with ground tints. Again, the Convention supports hill shading.

The advocates of the layer system put their case thus: the General Map is primarily a map for navigation purposes, the Local Map is a map by which the airman fixes his position by comparing the ground beneath him with his map. The two series are entirely different in purpose, and there is, therefore, no objection to the employment of a different design. While agreeing to a system of hill shading for the Local Maps, they propose a layer system for the General Maps: a layer system, more than any other system, enables a navigator, on plotting his position and finding himself in the neighbourhood of an obstacle, to decide rapidly (and rapidity of decision is essential in view of the great speed at which aircraft travel) whether to cross the obstacle by climbing without the prospect of getting into further trouble on the other side, or to turn to port or starboard with the object of going round it. Moreover, when planning a flight, the navigator can select and plot his proposed course with greater ease on a layered map: a map on these lines will contain little aeronautical detail, and will be used in conjunction with "Instructions to Airmen" and "Lists of lights and ground marks." The layer system proposed is as follows: ground below 1500 feet, in white; then three shades of brown to represent ground below 3000 feet, below 6000 feet, and below 9000: above 9000 feet, white again.

The advocates of hill shading cannot agree that the General and Local Maps differ in purpose: they consider that the two series are complementary to each other, and that the General Map should show as much detail as the scale permits, the Local Map amplifying this detail. The design of both series should therefore be the same.

It has been found by actual drawing that the General Map can be made to give clearly a very large amount of the information required by the airman, provided a system of hill shading is employed. In many parts of the world it will be possible to show all the available detail on the General Map, and therefore on long flights there will be a big saving in the weight of maps to be carried, caused by the fact that, having the General Map, it will not be necessary to carry the Local Map. Again, it will be many years before Local Maps will be available for considerable areas of the Earth's surface: in many instances it will not be worth while producing Local Maps on account of the paucity of detail, and therefore the General Map will be the map which the airman will be compelled to use. The map must therefore be designed for the general purposes of the airman, and not with the primary object of depicting relief.

The tendency will be for the airman to use his General Map in preference to his Local Maps. On the main flying routes he will get to know his route as the motorist knows his road, and the General Map will serve his purpose, if carrying as much detail as the scale permits: if in difficulties he may turn to his Local Map, and he will certainly *not* be assisted by a different design. Moreover, in an aeroplane travelling at a high rate of speed, a change of Local Map might be necessary every seven or eight minutes. The airman will be materially assisted if his General Map is good enough (and it can be made so) to obviate this constant changing of sheets: even if he is flying by local sheets, because he does not know the route and the country is full of detail, or because he is only getting fleeting glimpses of the ground, he will rely on his General Map to take him over the corners of sheets, and he will not want to jump from one design to another.

The airman is committed already to the use of two series of maps: the advocates of the layer system propose that, in addition, books of reference should be employed. In a dirigible there is a table for the maps and a shelf for the books; in an aeroplane there are no such facilities. The maps must carry such information as the characteristics of aerial and marine lights, and the position and nature of wireless stations, ground signs, etc.: books must be consulted before the airman leaves the ground.

Dealing generally with the question of "*layers versus* hill shading," it is claimed that hill shading gives a truer picture of the ground, and that the airman receives material assistance from a picture: the layer system gives an unreal impression of a sudden jump in height from one layer to another. Moreover, a layer system gives too much importance to the relief of the ground; the other detail on the map is overpowered; among the darker shades of brown detail may be obscured. Again, ground covered by wadis or nullahs or cut up by low precipitous hills cannot be indicated by a layer system, and such information is of great value to the airman. No system of relief can give an airman an actual spot to land,

but by hill shading, the areas which offer the best chance of landing can be indicated.

There is also this point to be remembered: in the International 1/Million Series we have, or shall have, maps on which the layer system is employed. In flights involving the crossing of mountainous country, these sheets can be consulted beforehand, and, if necessary, carried: the General Aeronautical Maps will show clearly which sheets of the International Million Series are involved.

With reference to the actual system of layers proposed (white below 1500 feet, shades of brown to denote ground lying below 3000 feet, 6000 feet, and 9000 feet, and then white again above 9000 feet), it is agreed that, on the scale of the General Maps, it is not possible to have the layers at a smaller interval than those proposed, and an indication of change of ground-level limited to 3000 feet is not of real use to the airman. Many important features will not be indicated; for instance, a range of hills running up to 2000 feet above a plateau whose general level is 3500 will not be shown, except by spot heights in black: these spot heights may equally well mean that the ground slopes gradually up to these heights, and the airman will get an erroneous idea of the country. The advocates of the layer system propose to introduce contours or form lines to meet this difficulty. The colour used for these contours or form lines will have to be deeper than the deepest shade of tint to be employed, and the map becomes still more overloaded with the depiction of relief to the exclusion of other detail. Contours in any case will not be of assistance. They cannot be interpolated at a small-enough interval to show any detail of the ground. How the ground above 9000 feet is to be dealt with has not been stated. Hill shading has been suggested, but if it is agreed to use hill shading for these areas, which would appear to be most important in view of the heights at which aeroplanes fly, why not use hill shading for the whole map?

The balance of the argument appears to be in favour of the advocates of hill shading, who wish for similarity of design in the two series, and who do not think that the layer system proposed will give a sufficiently good indication of the ground. There is still the question of the actual navigation of aircraft. It is claimed that this is easier on a layer system than on any other, but hill shading and spot heights would appear to suit the aerial navigator equally well. By hill shading mountain masses and difficult country can be clearly shown, and avoided if necessary; otherwise the spot heights will give the airman the information he requires. In fog, in bad weather, or at night he will climb well above any spot height in the neighbourhood of his estimated position. If he has to come down under these circumstances, he will take to his local map (which is hill shaded) in the hope of picking up some little bit of detail as a guide to his position.

The three controversial points in connection with the Aeronautical Maps are therefore:

(1) Whether Mercator's Projection is the most suitable projection for the General Maps.

(2) Whether hill shading with ground tints or a layer system shall be employed on the General Maps for the depiction of relief.

(3) Whether railways shall be shown in red and the roads in burnt sienna, or the railways in black and the roads in red.

Except on these points, the proposals which have been put forward have met with fairly general approval ; it is, however, worth while running through the conventional signs in detail : there are points which require explanation, and certain signs have not so far been referred to.

As already stated, *forests and woods* will be shown in green ; orchards will be indicated by green dots in regular lines where the scale permits ; with regard to country covered by small orchards, vineyards, hop-fields, banana plantations, etc., the airman not only may get an idea of his whereabouts from their indication on the map, but he must also be warned off them. It is suggested that this information can be most suitably conveyed by lettering on the serial information plate. A mangrove swamp will be a green stipple on a blue ground.

The indication of *water* requires no comment ; the use of a blue stipple for swamps, etc., has been referred to ; areas liable to inundation will be shown by a blue stipple to warn airmen off them ; when such areas afford good landing grounds at certain times of the year, a note will be made in black on the serial information plate.

Railways have already been discussed. A *light railway* will be shown as a single red line with the letter L in black ; a *tramway* in the same way with the letter T in black ; when the light railway or the tramway runs along a road, the black letters only will appear : in both cases departures from the road must be clearly shown. It is not proposed to distinguish overhead electric railways and tramways ; an airman, in the event of a forced landing, will endeavour to keep clear of anything red as long as he is in a position to use his map ; then he uses his eyes *Railways under construction* will be shown by dotted red lines.

Overhead power lines will be indicated by the symbol for telegraph lines with the addition of the letter P in black.

With regard to *roads*, in the Convention it was laid down that a distinction should be made between "very visible" and "less visible" roads ; this proved to be unworkable, and no attempt has been made to apply this distinction. *Tracks* will be dotted.

Sandy desert and *sandbanks* will be indicated by a brown stipple ; sandbanks are shown up well by this arrangement. The *10-metre bathymetrical line* will be shown in blue, where the indication will be of value to the airman.

With regard to the *lettering*, other than Aerial information, this will be in black, in a different style to that employed for the Aerial information, and will be very limited.

With reference to the Conventional Signs for Aerial Information:—

Aerodromes and Emergency Landing Grounds.—The true shape and orientation will be shown; when this is not known, they will be shown as circular. No sign was laid down for a *Seaplane Station* in the Convention; the one shown is suggested, and combines well with other aerial information.

Wireless Telegraph Stations.—It is suggested that, when small and isolated, this symbol may bear a resemblance to a square; and a proposal is under consideration to use three arms at an angle of 120° . The method of distinguishing between the different forms of wireless and directional wireless has yet to be decided. The International Hydrographic Conference has adopted symbols for five different kinds of stations, but there are more than five to be provided for, and the symbols adopted are not altogether suitable for our purpose.

Aerial Lights.—When the light is at an aerodrome, the circle will circumscribe the aerodrome.

Marine Lighthouse.—This is one of the Admiralty symbols, except that the star is five-pointed instead of six-pointed. The sign for two or more lights in close proximity, such as harbour lights, is a new proposal; such lights are often a useful guide to the airmen, and the stars were found to take up too much room.

Light Vessels and Light Buoys.—There has been a great deal of discussion over these symbols; it seems desirable that the decisions of the International Hydrographic Conference should be adhered to, and the British Admiralty signs (a boat in elevation and a buoy in elevation) adopted. These signs are, however, unwieldy and take up too much room; in well-lighted waters the configuration of lights is not immediately or easily grasped; they are in elevation, and the airman sees objects in plan. The actual position of the light is indicated by a small circle on the water-line of the symbol, whereas the eye is caught by the star, representing a light, which appears at the top of each symbol. In crowded waters there are difficulties in showing the characteristics of the lights. The symbols shown are therefore proposed, and a comparison of two maps, one employing the Admiralty symbols, the other employing the proposed symbols, has resulted in favour of the proposed symbols. Light-buoys will not usually be shown, as they resemble closely the lights of fishing-vessels, but there are places, especially abroad, in which the indication of a light-buoy may be of value to the airman.

International Boundaries have been treated as aeronautical information; they involve customs, and are the boundaries of potential prohibited areas. The symbol suggested is more easily handled on a complicated winding boundary than that laid down for the International Million Series.

Heights.—The Convention proposed that the figures indicating heights should be surrounded by an oval ring; this was unsatisfactory, owing to possible confusion with ground marks. Now it is proposed that a black

triangle and dot should be used; but this is the symbol for trigonometrical heights; the heights on the aeronautical maps are shown only to the nearest 100 metres above the actual height. A dot with a number on either side stands out sufficiently well, and we do not run into double figures on the left-hand side of the dot. It has been suggested that a cypher should be shown on the left of the dot when the height is under 1000 metres, but the single number shows clearly the ground under 1000 metres, and this indication may be of value to the airman.

Aerial Corridor, or port of Entry. This symbol is not altogether satisfactory; it will be difficult to use on the general map when the aerial corridor is narrow or when aeroplanes are ordered to cross a boundary at a certain town or aerodrome. We may get a black mark looking at first sight like an aerodrome; two half-arrows, which can be combined into one arrow if necessary, would meet the case better.

Symbols in combination.—So much of the aeronautical information comes all in one place that this fact was one of the controlling factors in designing the symbols. It will be seen that they combine fairly well.

Isolated or Conspicuous Features call for no comment. It is intended that these features shall be indicated only when they are isolated or predominate over other features in the landscape to such an extent as to form valuable guides to the airmen. A gasometer in England, for instance, will not be of much value; most towns have them. On the other hand, such a feature as the Dashwood Memorial in Buckinghamshire might be a valuable guide to an airman's whereabouts.

Abbreviations for Descriptions of Lights.—The airmen must be saved any necessity for consulting books, and the characteristics of marine and aerial lights must therefore appear on the maps. An international scheme has been worked out, and applied to some hundreds of lights with success. Some examples are shown.

Finally, it is necessary to say that the very considerable expense of producing maps on the lines of these proposals is recognized, and no doubt it will only be possible to build up these maps gradually to their final form, producing meanwhile provisional series in, say, three colours, to give the airman some means of finding his way about. But it does seem to be most desirable that we should endeavour to establish a detailed scheme at the very start, in order that there may be no haphazard adoption of colours and symbols as the work progresses.

Before the paper the PRESIDENT said: I have much pleasure in introducing to you Colonel Lees of the Geographical Section, G.S., who is responsible for the construction of the maps for Air Services, and especially for the International Aeronautical Map now under consideration.

Colonel Lees then read the paper printed above, and a discussion followed.

Colonel E. M. JACK: I have one or two small remarks to make upon Colonel Lees' paper. I should like to repeat his emphasis on the fact that any

BRITISH PROPOSALS FOR INTERNATIONAL AERONAUTICAL MAPS OF THE WORLD. CONVENTIONAL SIGNS FOR THE BASIC MAPS.

	GENERAL MAP	LOCAL MAP
Ground	<i>Sterile</i>	
	<i>with Vegetation</i>	
Woods, Orchards, Vineyards, &c.		
Water Outline	<i>Rivers, perennial</i>	<i>See footnote</i>
	<i>Rivers, non-perennial</i>	
	<i>Marsh and areas of Inundation</i>	
	<i>Canals</i>	<i>Navigation Drainage Irrigation</i>
Relief	<i>Elevations, perennial Snow, Glacier,</i>	
	<i>Depressions, (Ravine, Wadi, &c)</i>	
Artificial Structures	<i>Towns, Buildings, &c.</i>	
	<i>Railways (and Tunnels)</i>	<i>Single Double Tribble or more</i>
	<i>Railways disused or under construction</i>	<i>Peck 1.2 mm. Interval 0.8 mm</i>

NOTES.

Where light railways or tramways are shown, the railway symbol is used with the addition of the letter **L** or **T** in black. In closely settled areas tramways will be generally omitted. Where light railways or tramways run along roads, except in closely settled areas, the letter **L** or **T**, in black, will be given but the railway symbol omitted.

Overhead power lines are distinguished from telegraph lines etc. by addition of the letter **P** in black.

INTERNATIONAL AERONAUTICAL MAPS OF THE WORLD

CONVENTIONAL SIGNS FOR AERIAL INFORMATION (BLACK) PLATES.

	SYMBOL	NORMAL SIZE IN MILLIMETRES	
		GENERAL MAP	LOCAL MAP
<i>Aerodrome (See notes I&II)</i>		True outline and orientation 2	To scale
<i>Emergency Landing Ground (See note I)</i>		True Outline 2; when a circle 1.5 (see note)	To scale When a circle
<i>Seaplane Station</i>		Three circles 4 (broken over land)	Four circles (broken over land)
<i>Wireless Telegraph Station, with Radio Goniometer, with Radio Telephony.</i>		Cross 2. H ^o of letters .8	Cross 2. H ^o of letters .8
<i>Meteorological Station in conjunction with a wireless telegraph station.</i>		"	"
<i>Mooring-mast not at a landing-ground (See note II)</i>		Circle 1.2	Circle 1.2
<i>Name of Aerodrome, Seaplane Station, &c.</i>	FELTHAM	Height of letters 1.2	Height of letters 1.2
<i>Aerial Ground Signs showing form of sign (See note VI)</i>	REDHILL 6 9L2 ↑	Height of letters 1.1	Height of letters 1.1
" " " form not shown.....		1 x 2	1 x 2
<i>Prohibited Area, small; large</i>		Dots 0.5 apart, lines 1 apart. Width of ruling 2.	Dots 0.5 apart, lines 1 apart. Width of ruling 2.
<i>Aerial Lights</i>		Inner Circle 2 Outer Circle 2.4	Inner Circle 2 Outer Circle 2.4
<i>Marine Lighthouse; 2 or more Lights in close proximity, e.g. harbour lights.</i>		Inner Circle .8 Outer Circle 1.7	Inner Circle .8 Outer Circle 1.7
<i>Light Vessel; Light Buoy</i>		Inner Circle .8 Outer Circle 1.7; 9	Inner Circle .8 Outer Circle 1.7; 9
<i>International Boundary</i>	+++++	Cross 1, interval 1.	Cross 1, interval 1.
<i>Line of Equal Magnetic Declination</i>	---5°W---	Peck 2, interval 1. Height of letter 1.2	See magnetic declination on Plate
<i>Heights, in thousands of metres to one place of decimal, the decimal point indicating the position</i>	5.8 2.0 4	H ^o of figures 1.1	H ^o of figures 1.1
<i>Wells, permanent; temporary (See note III)</i>		Semicircle 1.5	Semicircle 1.5
<i>Aerial Corridor</i>		Height of letters .8	Height of letters .8

	SYMBOL	NORMAL SIZE IN MILLIMETRES		SYMBOLS IN COMBINATION
		GENERAL MAP	LOCAL MAP	
<i>ISOLATED OR CONSPICUOUS FEATURES (See notes IV & V)</i>				
<i>Fort</i>		1.4	1.5	<i>Aerodrome with Wireless Tel. Station</i>
<i>Castle, Mansion</i>		1 x .6	1.4 x .8	<i>Aerodrome, Seaplane Sta. & Wireless Tel. Sta.</i>
<i>Ruin</i>		1 x .9	1.2 x 1	<i>Aerodrome, Seaplane Sta., Wireless Tel. Sta., Radio Goniometer, Radio Telephony, Meteorological Station, Aerial Light & Aerial Ground Sign.</i>
<i>Factory Chimney</i>		.6	.8	<i>Aerodrome with Aerial Light</i>
<i>Spire or Steeple, Belfry, Tower, Pagoda, Minaret &c.</i>		1	1.2	
<i>Gasometer</i>		.8	1	

NOTES

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When the true outline of Landing-grounds (Aerodromes and Emergency Landing-grounds) is not known

IN MILLIMETRES
LOCAL MAP
To scale
To scale When a circle 2.5
Four circles 5 (broken over land)
Cross 2. H ^o of letters .8
"
Circle 1.8
Height of letters 1.5
Height of letters 1.1
1 x 2
Dots 0.5 apart, lines 1 apart. Width of ruling 2.
Inner Circle 3 Outer Circle 3.5
Inner Circle .8 Outer Circle 1.7
Inner Circle .8 Outer Circle 1.7; .9
Cross 1. interval 1.
See magnetic symbol on Plate 3
H ^o of figures 1.1
Semicircle 1.5
Height of letters 1

TION
BATH
HULL
BREST
WELLS

ounds (Aerodromes
not known, it is

ABBREVIATIONS USED IN DESCRIPTION

CHARACTER OF LIGHT

T = Temporary or Seasonal. Lights which are not permanently

A = Alternating. Lights which change colour.

F = Fixed. A continuous steady light.

G = Group. Used in conjunction with "E" or "C" to indicate a group of more flashes or eclipses occurring at regular intervals.

E = Flashing. An intermittent light where the total duration of light is less than that of darkness.

C = Occulting. An intermittent light where the total duration of light is more than that of darkness.

R = Revolving. A light gradually increasing to full brilliancy and then returning to eclipse.

THE ABBREVIATIONS ARE USED IN THE FOLLOWING ORDER —

I— Number of lights if more than one, represented by the single symbol, or more than two if represented by the double symbol. The subsequent descriptions are coupled together severally by the symbol "&" when necessary for clearness, the higher light or the port light, as observed from seaward being described first.

II— Character. The order of letters denoting character is that given above; where none is given the light may be assumed to be fixed.

III— Period (in seconds) between successive commencements of the same phase and Number of Flashes or Eclipses, if more than one with flashing or occulting lights or more than two with group lights. When both numbers are used they are separated by a hyphen. Where it is required to describe the individual phases, the number of flashes or eclipses is replaced by the duration of every phase in seconds, in the correct order, throughout the period and these numbers are separated by commas.

IV— Nature. Where the nature is not given it may be assumed to be white. Where the duration of the phases is given the natures are shown in the same order and separated by

commas
phases
correct
light or
the exa

V— Height
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NOTE 1.
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NOTE 2.
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EXAMPLES —

★ F 10 = Lighthouse, single light, fixed, white, 10 metres high.

★ Fr/v 13-17 = Lighthouse, single light fixed, sometimes red & sometimes white, visibility 17 nautical miles.

★ E 10 r 7-15 = Light-ship, single light, flashing, one flash every 7 metres high, visibility 15 nautical miles.

★ TAE 60-2 rw 20-11 = Lighthouse, temporary or seasonal, and flashing, two flashes every minute the first 20 metres high, visibility 11 nautical miles.

★ 2C & E 90-3 & 60 w 10-10 = Light-ship with double lower light flashing; higher light with 3 eclipses every minute; both a height of 10 metres and visibility of 10 nautical miles.

★ 3 F rrw 10 = Three lights close together, all fixed, from seaward) and centre light red and the

metres high.

★ 30-15, 6, 5, 17.5 w, m, m, 12-11 = Light-ship; single light; flashing

DESCRIPTIONS OF LIGHTS

	NATURE OF LIGHT
manently in operation.	<i>e</i> = electric
	<i>w</i> = white
	<i>r</i> = red
cate a group of two or ilar intervals.	<i>v</i> = green
	<i>b</i> = blue
tion of light is less than	<i>p</i> = purple or violet.
ation of light is equal to	<i>m</i> = masked
liancy and then decreas-	<i>i</i> (used after "e", "w", "r", "v", "b" or "p") = a flash of greater intensity.

commas. With alternating lights where the duration of the phases is not given, the nature of each flash is given in the correct order, separated by commas. Where the nature of a light or phase varies irregularly, e.g. with tidal lights, or where the exact nature is not known, the fact is shown thus: *r/v*.

V-Height in metres above sea-level and **Visibility** in nautical miles from a point 5 metres above sea-level. When both numbers are given they are separated by a hyphen. When only one number is given it indicates height except when "mil" is written after the number when it indicates visibility.

NOTE 1.

Where the double symbol is used, instead of the descriptions being coupled together severally by the symbol "&" they may be tabulated, the order not having reference to the positions of the lights, thus:- $\star \begin{smallmatrix} 5F \\ 2Fr \end{smallmatrix}$.

NOTE 2.

Where lights vary in horizontal sectors only in being masked to landward, the fact is not shown; otherwise the limitations and descriptions of such variations are shown thus:-

site, 10 metres high.

mes red & sometimes green, 13 metres high,

hing, one flash every 10 seconds, red,
al miles.

y or seasonal, single light, alternating
minute the first red the second white,
al miles.

h double light, higher light occulting,
ith 3 eclipses every minute and a half,
ute; both lights white; both lights with
y of 10 nautical miles.

all fixed, light on port side (approaching
d and the other light white, all lights 10

Symbol or Abbreviation, Name, Height, Length, Width, etc.						NOTES
Gasometer.....	□	.8	1			<p>NOTES</p> <p>I Where the true outline of Landing-grounds (Aerodromes and Emergency Landing-grounds) is not known, the outline shown as circular.</p> <p>II The facilities for aircraft at aerodromes are indicated by letters, in sloping Egyptian Capitals, under the name of the aerodrome, as follows:</p> <p>A = Hangars for aeroplanes H = Hangars for dirigibles F = Balloon inflation plant D = Customs P = Mooring-mast for dirigibles.</p> <p>III Wells are only shown where of especial importance in arid regions.</p> <p>IV Conspicuous features are only shown where they are isolated or dominate over other features of the landscape.</p> <p>V Conspicuous features not included in the above may be shown as they occur, together with their descriptions thus:—</p> <p>VI Where at a landing-ground the form of the aerodrome ground sign is the name of the station written in the symbol for a ground-sign is not employed.</p>
Cemetery.....	⊞	1X.8	1.2X1			
Quarry, Mine, open to the sky.....	⋈	1.4	1.6			
Windmill.....	⋈	.6	.8			
Monument, Pillar, Cairn.....	⊞	.9	1			
Bridge, Viaduct.....	⊞	.8	1			
Lock; Dam or Weir, (on river or canal).....	⋈	.8	1.1			
Building.....	■	.8X.5	1.1X.5			
Prominent Tree or clump of trees; Rock.....	⋈	.9	1.1			

ounds (Aerodromes
not known, it is

omes are shown
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oplanes
gibles
plant

dirigibles
cial importance in

n where they are
tures of a like

n the above list
ther with their

of the aerial
on written in full, the
yed.

NOT 11-10 = three lights close together, all fixed,
from seaward) and centre light red and the
metres high.

★GE 30-15, 6, 5, 17-5 w, m, w, m, 12-11 = Light-ship; single light; flash
as follows: 1½ seconds white, 6 seconds eclipse, 5
eclipse; height 12 metres; visibility 11 nautical miles

△F 3 mil Light buoy with fixed white light, visibility 3 nautical miles

★AFE 60-24, 6, 24, 6 w, w, r, i, 33-16 = Lighthouse; alternating five
seconds; phase as follows: 24 seconds white, 6 seconds
white, 6 seconds red flash; height of light 33 metres

★^{5F}_{Fv} 2F_v = Eight fixed lights: five white, two red, one green

NAMES:—

Names of lights are only given when marked so as to
Names where given are printed in upright Egyptian
in sloping Egyptian capitals and lower case; the
1 millimetre for the capitals and .7 for the lower

★ GULL
GE 20-4 w 12-10

*an fixed, light on port side (approaching
d and the other light white, all lights 10*

*light; flashing; period 30 seconds; phases
s eclipse, 5 seconds white, 17½ seconds
nautical miles.*

bility 3 nautical miles.

*minating fixed flashing light; period 60
white, 6 seconds white flash, 24 seconds
ght 33 metres, visibility 16 nautical miles.*

d, one green.

*arked so as to be visible from the air.
pright Egyptian capitals, description
or case; the normal height being
or the lower case, thus:—*

2