achievement of recent years is the opening of the Canadian Pacific Railway, and the establishment of a line of steamers connecting its western terminus with India, China, and Japan. We thus gain a shortened route to the East, passing entirely over great ocean highways and British territory instead of through a land-locked sea and a narrow gut which accident or design may at any moment render impassable. In view of the expansion of commerce during the last half-century, and of the immense undeveloped resources of Canada, it would be rash to set any limits to the future possibilities of this great Imperial highway.

"The universal acceleration of locomotion and transit is the most extended and general application of science to the great modern purpose of economizing labour and time. Every department of industry can, however, show special applications for effecting the same result."

ATLANTIC WEATHER CHARTS.

THE Meteorological Council has recently issued the second part of the Synchronous Weather Charts for the North Atlantic and the adjacent continents, the folio just published embracing two charts for each day from November 8, 1882, to February 14, 1883. The first part was noticed in NATURE, vol. xxxv. p. 469, when we gave a somewhat detailed explanation of the charts and the observations upon which they were based. The second part embraces a very large portion of an English winter, and the conditions pictured over the Atlantic show that the weather over that ocean in winter is far more disturbed than it is during the summer months. The barometer in the winter ranges both higher and lower, and the changes of pressure are much more rapid and considerable. The movements of the travelling disturbances are also accelerated, and keep in a much lower latitude, the British Islands coming frequently under their full influence after they have passed over the warm and moist air of the North Atlantic. In the summer the barometer is above 30 inches over the greater part of the ocean, but the highest readings seldom exceed 30·3 inches, whilst the areas of low pressure, the readings at the centre of which are seldom especially low, ranging for the most part from 29·2 to 29·5, skirt to the north of the high-pressure area, and pass as a rule well to the northward of the United Kingdom. At times these low-pressure areas scarcely influence our weather. At other times, when from some cause the high-pressure area is situated in rather a lower latitude than usual, the low centres will have a more southerly route in their passage from west to east, and will occasion disturbed weather over our islands, but for want of sufficient difference of barometric pressure will but very seldom materially augment the strength of the wind. If, however, this southerly track of the disturbances is maintained for any length of time in the summer, it will have a very marked effect upon our weather, occasioning frequent and heavy rains; it was this which caused the entire failure of real summer weather in 1879. The winter charts show that the barometer often ranges as high as 30·5, 30·6, and 30·7 in Mid-Atlantic, whilst on the adjacent continents such readings are common, and in North America much higher readings occur—on February 1 the mercury reached 31·1 inches. The charts do not extend to Siberia, but it is notorious that excessively high readings are commonly experienced there during the winter months. The low-pressure areas which are principally limited to the ocean, and almost solely to the northern latitudes, frequently have the barometer at the centre below 29 inches, and occasionally below 28 inches. With these differences of barometric pressure there is ample material for the development and maintenance of storm systems; and the most cursory examination of the charts shows to how great an extent storm after storm rages almost daily in one part or another of the Atlantic, and frequently several storm areas exist at one and the same time. This second series of charts illustrates in the most unmistakable manner the behaviour of storms over the Atlantic: many a disturbance can be traced in its progress for days together. On November 13 a storm area was passing over the north of France, and was occasioning strong easterly gales in the south of England and the English Channel. This disturbance can be traced back day by day until November 3, when it was in the vicinity of the West Indies, where it was apparently bred. The severe storm which was blowing over the British Islands on November 19 was apparently formed over central North America on November 9, and, after travelling slowly over the Lake District, left the Gulf of St. Lawrence on November 14, and followed a north-easterly track, but, after passing over the south of Greenland, it took a more southerly course, the centre subsequently passing between Iceland and Scotland. A fairly good specimen of storm development is shown on the charts of February 7 and 8: on the 7th, a bend is shown in the isobars of 29·0 and 29·1 at about 300 or 400 miles to the west of Ireland, and this on the following day becomes a closed area with its complete wind circulation; the disturbance, however, dies out again on the 9th. A feature of very special interest in the charts is the size of some of the disturbances: this stands out clearly from the graphic manner of representation. There are many instances of a gale blowing simultaneously in America and Europe, due to the same storm area, and in these cases the area of low-barometer readings usually occupies the whole of the northern part of the Atlantic, whilst over the land, both in Europe and America, the barometric pressure ranges very high. On January 23, as the result of a single low-pressure area, a gale was blowing in Hudson's Bay, Labrador, and Newfoundland, and completely across the Atlantic to the North Sea and the north of Norway, the diameter of the area over which the wind was blowing with gale force, being as much as 3800 miles (nautical); the centre of the storm was situated off the south-west coast of Greenland, where the barometer was reading 28·2 inches, whilst in America and Europe the barometer reached 30·8 inches. An almost equally large disturbance is shown on February 10, the gale force extending quite across the Atlantic from Labrador and the Gulf of St. Lawrence to the Gulf of Bothnia, the diameter of the gale area being fully 3000 miles.

The equatorial doldrum is shown to be of less extent than the general charts which have been deduced from averages would lead one to suppose, and very frequently the north-east and south-east trades almost meet. Between longitudes 20° and 30° W., the position at which the trades meet in November is about 5° N., in December about 3° N., whilst in January and the early part of February the south-east trade only just blows north of the equator, and the doldrum is probably at this time at its most southern limit. The north-east trade is far more regular on the eastern side of the Atlantic than in mid-ocean or on the western side, and this is fully accounted for by the fact that the wind blows round the Atlantic high-pressure area in agreement with the ordinary anticyclonic circulation, so that on the eastern side of this high pressure which is also, as a rule, the eastern side of the Atlantic, the wind is northerly, whereas to the westward of this area of high barometer readings the winds are frequently from the southward. The northern margin of the trade varies considerably, and is almost entirely dependent on the position of the area of high barometer situated over the Atlantic; when this area is well to the northward the northerly winds hold from the chops of the Channel down the coast of Africa to about 5° N., so that a vessel may leave England and keep a steady northerly and north-easterly wind until close to the equator.

The winter charts also show that the differences of temperature are much larger over the Atlantic than they were in the summer or autumn series, and the isotherms of both air and sea run much closer together. On November 25 there is a difference of 30° in the sea temperature in the distance of 340 miles to the south-east of Newfoundland, whilst on the eastern side of the Atlantic the same difference of temperature, 40° to 70°, spreads over 2360 miles. This disparity between the difference of temperature on the western and eastern sides of the Atlantic is quite common throughout the whole period of the charts, but not always to so large an extent. The charts of December 15 and 19 are other instances which show this difference, and on January 6 there is a difference of 30° (from 30° to 60° F.) in 120 miles off the south of Newfoundland, whilst on the eastern side there is only an equal difference of temperature (50° to 80°) in 3300 miles. The largest differences of temperature occur between latitude 40° and 45° N., and longitude 40° to 60° W., which is the area most affected by the meeting of the warm water of the Gulf Stream and the cold Polar current, and the weather which is given on each chart shows that there is almost constant rain in this position, and it is also the breeding-place of many a storm area, and storms when generated have a decided tendency to keep in the track of the Gulf Stream.

These synchronous charts will materially aid investigators in tracing the connexion between the weather in the British Islands and that over the Atlantic, and as it is not possible at present to know what is going on immediately to the westward of us, it is the more necessary to deduce, if possible, laws which regulate the changes from time to time. By the publication of these charts the Meteorological Council afford opportunity for testing many theories. Among these may be mentioned the theory of indraft of wind towards the centre of a cyclone, if this is not already pretty conclusively proved Light is also thrown upon the question as to the position of rain with regard to the position and development of the general storm area, and upon many other inquiries of a similar nature. We hope that after the two remaining parts of the work have been completed the Council will see their way to undertake a thorough discussion of the material which the charts contain.

A REVIEW OF LIGHTHOUSE WORK AND ECONOMY IN THE UNITED KINGDOM DURING THE PAST FIFTY YEARS.[1]

II.

THE fifty years of the present reign have been distinguished with regard to lighthouse illumination by the development in this country of the beautiful dioptric system of Augustin Fresnel. In 1837, this system had been established in France fifteen years, but had only just been introduced into Britain, where the catoptric system was in full operation. Parabolic reflectors formed of facets of silvered glass were used in the Mersey lighthouses so far back as 1763, and at Kinnaird Head, in Scotland, in 1787. In 1804, perfected reflectors of silver plate rolled upon copper were used at Inchkeith, and similar reflectors have been ever since employed. To Teulère must be attributed the honour of the invention of these parabolic mirrors, in 1783. The Inchkeith Lighthouse is also notable as the first in Britain to receive a Fresnel apparatus (1835), through the exertions of Alan Stevenson, who placed the next one at the Isle of May (1836), and the third at the Start (1836). These lights were all of the first order, Start and Inchkeith being revolving, and Isle of May fixed. They were constructed by Messrs. Cookson, of Newcastle, who subsequently constructed at least a dozen others, mainly as regards the refracting portion.

The lenticular system, as received from Augustin Fresnel by Alan and Robert Stevenson, comprised four principal optical agents of glass, viz. the cylindrical refractor, the totally-reflecting prism, the refracting vertical prism, and the annular lens. These have been continued in use, with few modifications, until the present day, while his auxiliary elements, such as the small inclined lenses, the silvered metallic zones, and the plane silvered glass mirrors, have been abandoned. The first-order fixed light of Fresnel came well-nigh complete from his hands, and has remained unchanged in size and character, save as relates to the number of prisms above and below the lenses, which has been increased from 19 in all to 26, and as to the joints of the lenses, which have been made inclined instead of vertical, the latter improvement being due to Alan Stevenson, who also introduced a refractor of more truly cylindric form. It is in the apparatus of revolving sections that the most striking ameliorations have been effected. The French engineers added little between 1822 and 1852 to Fresnel's original work, a few combinations or modifications of his elements to produce flashes alternately with fixed light being nearly all. But between 1849 and 1852 the great improvement known as the holophotal system was elaborated by Mr. Thomas Stevenson. It is difficult to describe without drawings the various applications to both catadioptric and dioptric instruments of this principle, by which the light of maximum intensity, or the best utilization of all the rays, was attained. The first *catadioptric* holophote was employed at the North Harbour, Peterhead, in 1849. Better forms were realized in 1864. The first use of holophotal metallic mirrors above and below the annular lenses of a large revolving light was at Little Ross. These mirrors, which needed no small auxiliary Fresnel lenses, were, instead of being plane, like Fresnel mirrors, generated by a parabolic profile passing round a horizontal axis. The typical *dioptric* holophote is a central refracting lens of usually three elements, with a series of concentric holophotal totally-reflecting rings, forming an instrument of varying diameter and focal distance, condensing into a parallel beam all the front arc of the diverging sphere of rays. The holophote is perfected by a glass spherical mirror of totally-reflecting prisms so shaped and set as to return all the back hemisphere of incident rays through the flame, to be parallelized and sent out with the front hemisphere of rays. This spherical mirror in its most effective form was the invention, in 1861, of Mr. James Chance, who generated the double-reflecting prisms or zones round a vertical instead of a horizontal axis, separated them, and divided them into segments or panels, thus making it practicable to increase the radius of the mirror and apply it to the largest apparatus as a most useful adjunct. In this instrument the image of the flame is not reversed, and the light sent back is at least three-fourths of that received.

But the most important application of the holophotal system was to the dioptric revolving sea-light. The totally-reflecting zones above and below the refracting lenses were generated round a horizontal instead of a vertical axis, and made to work in complete unison with the lenses, the light being parallelized in every plane from top to bottom. The first holophotal sea-light was the North Ronaldshay, in 1851. Since that date every revolving light with prisms has been holophotal. It has been estimated that the modern plan gives light five or six times more intense than the original plan.

Another material addition to the resources of the lighthouse engineer has been contributed by Mr. Thomas Stevenson in the azimuthal condensing system. This is, briefly, an arrangement of the optical agents before described, and of some others specially devised, by which either one arc of the horizon is illuminated by a beam of the greatest attainable intensity while the rest is dark, or else two or more sectors are lighted with equal or with unequal intensity while the others are dark; these distinctions being governed by the nautical requirements as to range and direction of the sea-coast, channel, or harbour

[1] Continued from p. 105.