ful color, the light growing redder the farther it traversed the atmosphere.

In a recent article[1] Professor Langley states his belief that much of this diffusion of the blue rays, as also the general absorption of the whole spectrum, is due to fine dust-particles in the atmosphere. The very strong absorption of the blue rays of the arc-light by fog would seem to suggest the inquiry whether the average size of the minute water-drops forming this fog has any thing to do with the remarkably selective effect upon the blue wavelengths, or whether this is simply the absorption effect of water *en masse*.

With the failure of the arc-light to penetrate fog comes the natural inquiry, whether the incandescent lamp will be any better for lighthouse and search-light purposes. Now, the part of the solar spectrum most free from atmospheric absorption-lines is in the orange, with part of the neighboring yellow and red; and some experiments have shown that this region — or the yellow part of it, at any rate — is that in which the incandescent carbon filament is especially rich, relatively more so than the solar spectrum, and it is the brightest part of that. So that there would seem to be every probability that the incandescent lamp would prove very effective in fog penetration, perhaps most efficiently so at a slightly lower temperature and brilliancy than the present average. The difficulty for lighthouse and search-light purposes would be in concentrating a sufficient amount of luminous radiating filaments in a very small space near the focus of a lens or mirror, which is a strong point in the effective use of the arc-light. With single-filament lamps this would be impossible; but the writer can see no insuperable difficulty in arranging a whole bunch or cluster of interlacing loops, joined in multiple arc within the same exhausted globe, so as to present almost a complete network of filaments over a vertical projection of an inch or two square, and yet not have them touch each other; unless, indeed, the great heat might soften the globe enough to let it collapse; and this could probably only be determined by experiment. The suggestion that a slightly lower temperature might be about as effective in fog penetration would help a little, but not very much, on account of the rapid decrease of luminosity, with slight fall in temperature. Special care would need to be taken to make each of the filaments of the cluster of equal resistance with the others; but no more so than in any set of lamps on the same circuit, and no doubt all the difficulties could be speedily surmounted. Some experiments upon the fog-penetrating power of the incandescent lamp would certainly seem to be worthy the attention of those engaged in these matters; for there can be no question about the far greater convenience, cleanliness, safety, and reliability, of the incandescent lamp over all others, even if it is not so economical. But in government lighthouses and war-ships the economy is not so important, reliability and fog-penetrating power being the prime requisites. H. M. PAUL.

[1] *Philosophical magazine*, October, 1884.

RECENT DETERMINATIONS OF LONGITUDE ON THE WEST COAST OF SOUTH AMERICA.

THE recent completion of the longitude measurements on the western coast of South America by the U. S. naval officers, under the command of Lieut.-Commander Charles H. Davis, U.S.N., affords a remarkable proof of the accuracy of the methods and instruments now in use for such operations. Lieut.-Commander Davis commenced his measurement in November, 1883, at Valparaiso, and terminated it in March, 1884, at Panama; connecting there with the chain of measurements made in 1875 by Lieut.-Commander F. M. Green, U.S.N., and measuring from Valparaiso to Arica, Arica to Payta, Payta to Panama,[1] and in December, 1883, with the aid of Dr. B. A. Gould, director of the Cordoba observatory, from Valparaiso to Cordoba. This work completes the telegraphic measurement of the polygon Washington–Key West, Key West–Havana, Havana–Santiago de Cuba, Santiago–Kingston, Kingston–Aspinwall, Aspinwall–Panama,[2] Panama–Payta, Payta–Arica, Arica–Valparaiso, Valparaiso–Cordoba, Cordoba–Buenos Aires, Buenos Aires–Montevideo, Montevideo–Rio de Janeiro, Rio de Janeiro–Bahia, Bahia–Pernambuco, Pernambuco–St. Vincent, St. Vincent–Madeira, Madeira–Lisbon, Lisbon–Greenwich,[3] Greenwich–Washington.[4]

This great chain of longitude measurements, consisting of twenty links, closes with but an insignificant discrepancy; the longitude of the Cordoba observatory by way of Lisbon, Rio de Janeiro, and Buenos Aires, being 4 h. 16 m. 48.06 s., and by way of Wash-

[1] Report of the U. S. coast-survey for 1875, appendix No. 11.
[2] Telegraphic longitudes in the West Indies and Central America, Washington, 1877.
[3] Telegraphic longitudes on the east coast of South America, Washington, 1880.
[4] U. S. coast-survey report for 1870.

ington, Panama, and Valparaiso, 4 h. 16 m. 48.24 s., showing a discrepancy of only 0.18 s.

These measurements have, with the exception of those joining Greenwich and Washington (made by the U. S. coast-survey) and those joining Valparaiso and Buenos Aires (made by Dr. B. A. Gould), been made by officers of the U. S. navy, and are homogeneous, each determination being the result of repeated comparisons through a telegraphic line of time-pieces whose errors on local time were ascertained on the same night by careful transit observations.

It will, of course, be understood that the remarkably small discrepancy (0.18 s.) by which this great polygon fails to close is the algebraic sum of all the errors affecting the various longitudes; but its very small amount is an indication of the care and painstaking of the officers whose labors have given this result, as well as of the accuracy of the instruments and methods employed.

In addition to his valuable work between Panama and Valparaiso, Lieut.-Commander Davis has recently determined telegraphically the longitude of Vera Cruz by measuring from Galveston, and has, on the west coast of Central America, furnished the Guatemalan boundary commission with a starting-point by fixing from Panama the longitude of Guatemala City (in co-operation with Mr. Miles Rock). A detailed report of the work of Lieut.-Commander Davis will shortly be published by the U. S. navy department.

THE KILIMANJARO EXPEDITION.

AT a meeting of the Royal geographical society, Jan. 26, Mr. H. H. Johnston gave a description of his visit to Kilimanjaro, on the slopes of which he spent more than five months in the summer and autumn of last year.

Giving a lively and picturesque narrative of his adventures during his stay with Mandara, chief of Moshi, a person of remarkable character, who rules a small tract on the lower slopes of Kilimanjaro at an altitude of about 6,000 feet, and is at war with all the surrounding potentates, Mr. Johnston told how, after some difficulties, he began the ascent of the mountain with forty carriers and some guides, provided by another chief, Maranga. As a good place for settlement close to water, and not too high up, so that his shivering followers might not suffer unreasonably from cold, he selected a grassy knoll, rising above the river of Kilema, which takes its source near the base of Kimawenzi. The altitude of this spot was nearly 10,000 feet. Having seen every one carefully installed and protected from the — to them — severe cold (for the thermometer descended every night to one or two degrees below freezing-point), he transferred his own quarters to a higher elevation, and began industriously to collect.

His first excursion was to the base of Kimawenzi. The terrible hurricane of wind, however, that raged round this jagged series of lava-peaks, prevented him from continuing the ascent, although he doubted if it were possible for any one to reach the summit, owing to the want of foothold. The snow varied very much in quantity on Kimawenzi. Sometimes the whole peak would be covered down to the parent ridge, with only the precipitous rocks peeping blackly through the mantle of white. At other periods the snow would be reduced to an insignificant patch, and the reddish sand which filled the crevices and glissades between the lava-rocks would be left exposed to view. This change from an almost complete snow-cap to nearly no snow at all might be effected in twelve hours.

His great object, however, was to reach the snows, and, if possible, the summit of Kibô. To do this it would be necessary to sleep on the way. He had, therefore, to induce a few followers to accompany him to carry impedimenta. Starting at 9, he walked upwards, with few stoppages, until 1.30. At first they crossed grassy undulating hillocks, the road being fairly easy. Then they entered a heathy tract, scorched and burnt with recent bush-fires; but higher up, where the blaze had not reached, the vegetation was fairly abundant and green. Small pink gladioli studded the ground in numbers. At an altitude of nearly 13,000 feet, bees and wasps were still to be seen, and bright little sun-birds darted from bush to bush, gleaning their repast of honey. A little higher they found warm springs, the thermometer showing the temperature of the trickling mud to be 91° F. Mounting high above the rivulet, the scenery became much harsher. Vegetation only grew in dwarfed patches as they passed the altitude of 13,000 feet, and the ground was covered with bowlders more or less big, apparently lying in utter confusion, and without any definite direction. They were not very difficult to climb over, and even seemed to act as irregular stone steps upwards. In their interstices, heaths of the size of large shrubs grew with a certain luxuriance. About 13,700 feet, he saw the last resident bird, apparently a kind of stonechat. It went in little cheery flocks, and showed such absence of fear, that he had to walk away from it before shooting, to avoid shattering his specimen. After this, with the exception of an occasional great high-soaring kite or great-billed raven, he saw no other bird. On reaching a height a little above 14,000 feet, he stopped again to boil the thermometer and refresh himself with a little lunch. Throughout this ascent, which was easy to climb, he suffered absolutely nothing from want of breath, or mountain sickness; although his three Zanzibari followers lagged behind, panting and exhausted, and complained much of their lungs and head.

"Mounting up a few hundred feet higher than the

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