

scores of non-experts, as is seen not unfrequently in cases of poisoning; but the successful study of delusions is something very recent; it is, so to speak, just entering the domain of science; the number of experts in the subject is very limited, and those few are known as such only in a very narrow circle; consequently, their opinions are not sought for in litigated cases; but in their place, mediums and clairvoyants and their victims are invited to give their opinions under oath on one of the most difficult and important branches of science, the physiology and pathology of the nervous system.\* Years

\* This was illustrated in the famous Ward case in Detroit, in which any one thoroughly familiar with the subject of delusions, would have sworn, and could have sustained his oath by cogent and convincing reasoning, that a firm belief in spiritualism is not by any means a presumptive evidence of insanity, and thus would have avoided a long and useless trial.

In the Kiddle case, now before the public, the same question has been presented. There is no presumptive evidence that this hitherto successful superintendent of our public schools is insane, or likely to be; he is simply a non-expert. Cases of real or professed trance in his own family have puzzled him as they would have puzzled any one but a specialist in that department of the nervous system. Unable to account for these phenomena by laws that were known to him, he accounts for them—in accordance

hence, when the knowledge of this subject, now confined to a limited body of specialists, shall be somewhat diffused through society, and the fact of the existence of such knowledge shall be recognized, then, and probably not before, will it be possible to enforce any law designed to protect our people from clairvoyants. In this as in other matters, law follows public opinion more than it leads it. At the present time clairvoyants are very dear to the American heart; nearly every house is for them a castle; if seriously threatened, thousands would rally to their support. The remedy for delusions is not in law, but in a higher civilization.

with the accepted logic of the day—by the theory of spirits. His conclusion is unscientific, but his logic is unanswerable.

Indeed, if a belief in spiritism, in animal magnetism, in clairvoyance, in mind-reading, in the evidence of the senses, and allied delusions is proof of insanity, then this United States of America is but one vast asylum. As it is, delusions take but the third rank among the exciting causes that fill our institutions for the insane. In the twentieth century the true philosophy of trance, and kindred phenomena of the nervous system will be taught in all our schools; and then our pupils, our teachers, and our superintendents, will be saved from the evil consequences of false reasoning.

## THE FLOODING OF THE SAHARA.

"ACROSS the Sahara by steamer" promises at no distant day to be classed among the announcements of this age of mechanical and engineering triumphs. That the Sahara, the figure in the world's literature and oratory for barrenness and solitude, should lose its old character and put on a new one in contrast with the old, would be surprising indeed. The proposal on the part of English and French engineers to flood the great desert with the waters of the ocean and of the Mediterranean, and transform its waste into a watery highway for the commerce of the nations, at first impresses us as visionary and impracticable. A thorough examination of the subject, however, has led some of the most eminent scientists to quite a different conclusion.

The isolation of Africa has largely been due to the succession of cataracts with which nature has blockaded her great rivers. The Nile, the Niger, and the Livingstone, with their insuperable obstacles to navigation,

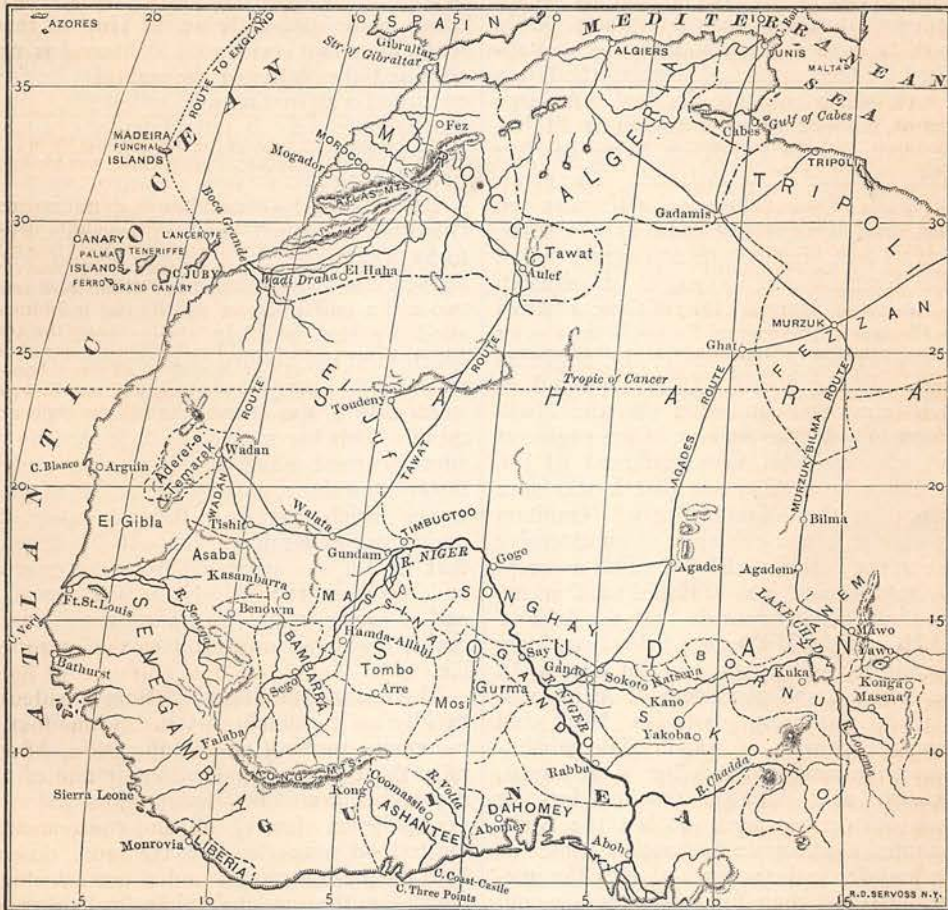
seem the very emissaries to the spirit of darkness, forbidding the entrance of light to his primeval domain. Though embracing within its boundaries nearly one-fourth of the entire land area of the globe, Africa has the smallest extent of coast line of all the continents. Few indentations are observed in its entire circuit, and consequently but few harbors exist. Its great desert, also, has always presented a barrier which the civilizations of the Mediterranean could not pass. Hence the great continent has remained undeveloped and comparatively unknown to the present. Exploration has, as yet, offered no satisfactory solution for the problem of opening Africa to the world. Stanley's magnificent achievement will be almost as magnificent for any bold adventurer who may follow in his footsteps, since the second, and probably all, descents of the Livingstone for decades to come, will be as difficult as the first. It is furthermore possible that the savages of the great river,

incensed by the vigorous reception with which Stanley met their opposition to his progress, may render it impossible for any one to follow in his footsteps during the present generation.

Probably the most original and feasible plan for laying open the heart of Africa is that recently proposed by both English and French engineers. It is no less than the remarkable suggestion which furnishes the

plan, we must examine the geography and topography of Northern and Central Africa.

The Saharan Desert embraces a vast region covering an area of about 3,000,000 square miles. Its boundaries are the spurs of the Atlas Mountains on the north, the Nile valley on the east, the Niger on the south, and the Atlantic on the west. It has been commonly believed that this entire district was a pathless waste, whose burning



MAP SHOWING THE PORTIONS OF THE SAHARA WHICH IT IS PROPOSED TO FLOOD FROM THE ATLANTIC AND THE MEDITERRANEAN.

subject of this article. Mr. Donald Mackenzie, the English engineer, proposes to flood the Sahara from the Atlantic, while Captain Roudaire and M. de Lesseps, the French engineers, are now engaged in work of a preliminary character with a view to admitting the waters of the Mediterranean to the basins of Tunis and Algeria. Mr. Mackenzie's project first merits our attention, and in order to a right understanding of his

sands were only occasionally relieved by oases of limited resources and extent. While this general impression is true of large areas of the sandy sea, whose billows, tossed by scorching winds, mercilessly bury man and beast in its tempestuous convulsions, still research has shown that by far the greater part of this vast region is diversified by snow-capped mountains, verdant valleys and occasional groves, and is watered by rivers

and torrents, which, while burying themselves in the sands, impart life to the vegetation growing above them.

The Sahara supports a large population, divided into nations and communities having walled towns and extensive plantations. Its climate in the more elevated districts is pronounced healthy and agreeable. In the Western Sahara, between the parallels 18° and 30° North Latitude, lies a large tract of impassable desert, so sterile and so forbidding that no wandering Arab or native Berber ventures to traverse its waste. Only upon its borders have stations been established for the purpose of working the layers of salt which compose its bed. A large part of this salt waste is known as El Juf, the great sink of the desert, being 200 feet below the level of the Atlantic. The greatest length of this depression is given as 500 miles, and the greatest width at 120 miles, with an area of nearly 60,000 square miles. Like depressions of less extent are situated in Tunis and Algeria. One of these, situated south-west of the gulf of Cabes, is the center of the French survey under the engineers previously mentioned. It is supposed to have been once connected with the Mediterranean. In the opinion of the engineers and scientists who have examined El Juf, there can be little doubt that it was once an arm of the Atlantic Ocean. Tradition reports the former existence of an extensive lake in the region of El Juf which was rapidly transformed into a sterile sand waste. Diodorus Siculus records that the lake of the Hesperides in Western Sahara suddenly succumbed to evaporation. In 681 A. D. the Arabs found the north of Africa well wooded, possessing extensive lakes and abundant streams of water. The inhabitants of the land, under shelter of the forests, harassed and defeated the invaders for more than a century. At last the Arabs instituted a wholesale destruction of the forests and drove the natives far into the interior. In less than five centuries it would seem that the destruction of the forests wrought the ruin of the vast region which is now blighted by the curse of the Sahara. In 1200 A. D. the lakes had become salt marshes which were rapidly disappearing. The streams, no longer supplied by filtrations of moisture from the once wooded districts, only now and then appeared in spasmodic and angry torrents, soon to be lost in the treacherous soil.

Gradually the equatorial winds, unchecked by forest growth, bore on the sands, until

the desert in its steady encroachments extended its blighting presence over the vast area which it now covers. Such is the tradition and such probably is the fact. While destruction of the forests may have contributed to the general result as described, the disappearance of the sea of El Juf was probably due to another cause.

Explorers agree that a channel once connected its north-western extremity with the Atlantic Ocean, at a point near Cape Juby opposite the Canary Islands. This channel, called by the natives, Sakiet El Hamra, presents abundant evidence of once having admitted the waters of the sea. Its bed is encrusted with marine salt, and shells. On the Atlantic coast it terminates in a sand-bank which prevents the waters of the ocean from flowing into its bed. Its great mouth, —Boca Grande,—resembling a miniature Gibraltar, is formed between perpendicular rocks which rise to a height of 200 feet above the sea; it measures between the rocks two and a half miles in width, and is blockaded by the sand-bar above mentioned, which itself has a width of 300 yards across, and a height above the sea of thirty feet at the south side of the channel, and ten feet at north. This bar was no doubt formed by a strong current which here sets continually toward the shore, and by the action of the waves which now beat furiously upon it during stormy weather. Thus it is believed that El Juf was separated from the ocean and became successively a salt marsh, and a sandy waste, whose surface is still covered with abundant remains of marine life.

The channel of Sakiet El Hamra widens rapidly as it extends inland. A chain of mountains running north and south, a few miles from the coast, does not interrupt its course but accommodates its passage by a perpendicular break, fifteen miles wide, located opposite the Boca Grande. The bed of the channel is estimated at 200 feet below the sea-level, while its banks in some places rise to a height of 500 feet. The ease with which El Juf could be flooded from the Atlantic is appreciated when we consider that all that is required is the excavation of a ship-canal 300 yards long through the sand-bar at the mouth of the channel.

Since the bed of the channel is at present 200 feet below the sea-level, the water of the sea could be utilized for the work of cutting the canal after a small ditch had once been dug across the bar. The torrent which

would pour through the opening would no doubt soon remove the greater portion of the obstruction. However, when the great inland basin had again been filled and the water level both within and without the great mouth had reached an equilibrium, it may be presumed that the same agencies which gradually built up the bar, namely, the tides and waves, would renew their work, and, if left alone, would probably in time close the channel and again reduce the Saharan sea to a desert. Still, the influence of these agencies could in part be counteracted by the current which must flow out of the channel.

The volume of the rivers which now flow into El Juf would no doubt be greatly increased by the additional rain-fall incident to the presence of so large a body of water. The action of the tides and currents could be guarded by breakwaters and entirely controlled by locks. In these alone it is believed must consist the trifling expense of an enterprise of far-reaching results. The only important objection which has thus far been urged against the undertaking has arisen in the apprehensions expressed by a few scientists that the evaporation produced by so large and so shallow a body of water, exposed to the tropical sun, would be sufficient to deluge northern Europe with incessant rains, and to reduce materially the temperature in all the countries north of the Alps. It has even been feared that winds freighted with moisture on crossing the cold summits of the Alps, would precipitate vast volumes of water and produce a degree of cold which would give Denmark and northern Germany a semi-Arctic climate and produce a glacial epoch farther north. Is it not probable that all such apprehensions arise out of a misunderstanding as to the topography of the Sahara and North Africa? The entire region to be flooded is practically shut in by mountain-chains on all sides. The Atlas Mountains on the north, lifting their snow-clad peaks in some instances 12,000 feet, afford a sufficient bulwark for the protection of Europe from increased humidity. The only possible northernly outlet for air currents from El Juf would be across Tunis in a north-easterly direction over the widest part of the Mediterranean. Currents moving in that direction, if they reached Europe at all, would touch the shores of Greece after they had lost most of their humidity. M. de Lesseps, after a careful examination of the question, is convinced that it would result in the general

improvement of the climate of Europe rather than to its detriment. The advantage of the increased evaporation to North Africa cannot be overestimated. The snow-clad cliffs of Aban, lying to the east of the proposed sea, and the Kong Mountains to the south, would bring down upon the parched desert grateful rains, which, with the assistance of cultivation, would in time no doubt redeem thousands of square miles from the desolation of the sands.

In estimating the advantages arising from the flooding of El Juf we must consider its relation to Central Africa on the one hand and to the civilized world on the other.

One hundred miles south of the limits of the proposed sea is situated the commercial metropolis of the heart of Africa—Timbuctoo, called "the queen of the desert." This venerable city, founded A. D. 1176 by the Berbers, the ancient people of North Africa, is situated six miles north of the Niger, when the river is at its ordinary level. In the rainy season, however, its western gates are washed by the overflow of the river. The city contains at present 20,000 inhabitants, though formerly it was much larger. Its regularly laid streets, well-built houses and magnificent mosques, with lofty minarets, present an imposing appearance, a picture of inviting beauty as it breaks upon the vision of the weary voyager of the desert. The Zangereber or great mosque is a stately edifice with nine naves, a lofty tower, and measures 286 by 212 feet. Several other mosques of importance and great age, add to the attractions of this strange and wonderful city. From time to time fabulous stories of the wealth and importance of Timbuctoo reached Europe, until it came to be regarded as a paradise of magnificence and luxury which had never been transcended in Arabian story.

The commercial advantages of the city, however, constitute its chief importance. From its port (Kabara), the Niger and its tributaries are navigable for thousands of miles. The wealth of Central Africa is brought to its gates, and is ready to be poured into its markets. The great central region bears the general name Soudan. Its area is estimated at 631,000 square miles, or five times the area of the British Isles. It has three physical divisions, the basin of the Niger, the district of Lake Chad, and the country between Lake Chad and the upper Nile. The Niger in its wanderings traverses 3,500 miles; but this vast circuit, embracing all the southern half of North-

Central Africa, is inaccessible from the ocean because of the rapids which block the river's mouth, and the general unhealthiness of its banks as it approaches the Atlantic. With this exception the vast region which it traverses, as well as most of Soudan, is pronounced salubrious.

Soudan has a population of 38,800,000, chiefly Fellatahs and Mandingoes. The latter people are supposed to be descendants of the Egyptians, as their language is quite similar to the Coptic. They are intelligent and progressive, pursuing agriculture, engaging in manufactures and trade, and furthermore support well-conducted public schools. Their language is written in Arabic and is said to be the richest of the African languages. The Fellatahs are, however, the superior and dominant race. Their fine features and noble bearing distinguish them as the people of intelligence and influence who must become the auxiliaries of the Europeans in the regeneration of Africa. Their love of knowledge, and their devotion to the humane principles of government and social life, have wrought great changes in the districts over which they have extended their dominion. Their color is not darker than that of Spaniards and Portuguese. The products of Soudan are cotton, the tamarind, bread-fruit, kajiji, the kola-nut, sugar-cane, rice, wheat, maize, barley, game in abundance, horses, cattle, asses, sheep, goats and camels. The minerals are gold, iron and copper. At present the foreign trade with Soudan amounts to \$20,000,000 per annum, though the caravans are obliged to traverse 2,000 miles of desert between Timbuctoo and the ports of Morocco, Algeria, Tunis, and Tripoli.

Were the Sahara flooded, and were it possible to steam from Liverpool or New York to Timbuctoo, the volume of trade would develop immensely. Port St. Bartholomew, the harbor which Mr. Mackenzie has established near Cape Juby, on the coast of Africa, is distant only 80 miles from the Canary Islands, and is within 1,600 miles of Liverpool. Cape Juby is distant less than 800 miles from Timbuctoo. The depression of El Juf approaches within 100 miles of the city. The flooding of El Juf would consequently bring Timbuctoo within ten or twelve days' steam of Liverpool. Ultimately, no doubt, a ship-canal would be constructed between the sea of El Juf and the Niger,—a distance of 100 miles,—with its thousands of miles of uninterrupted navigation. This accomplished, the heart of

Africa will be thrown open to the world, and the "Dark Continent" will exist only as a dream of the past.

As previously intimated, the French engineer, Captain Roudaire, and the celebrated M. Ferdinand de Lesseps, whose energy and skill in the construction of the Suez Canal made Africa an island, are now taking steps with a view to flooding the *chotts*, or basins of Tunis and Algeria, from the Mediterranean. The exact extent of these depressions, if known, has not been publicly stated. The preliminary work of leveling, by Captain Roudaire, showed the depressions to be lower than the level of the sea, and demonstrated the necessity of making borings in order to ascertain whether rocks underlie the sand which composes the intervening ridges. At the meeting of the French Academy of Sciences, held December 9, 1878, M. de Lesseps gave an account of his visit to Tunis in company with Captain Roudaire and his expedition. The exploring party arrived in the Gulf of Cebes in the latter part of November of the same year. The tidal rise and fall was ascertained to amount to two and a half meters in the gulf, while the average tidal variation of the Mediterranean is only three-tenths of a meter. Midway between the extreme limits of the Gulf of Cebes is the mouth of the Melah, a small river selected by Captain Roudaire to permit the flow of the water into the *chotts*. The tide ascends this river for several kilometers, retiring with such force that, at a distance of 500 meters from the shore, opposite the river's mouth, it has scoured out a channel forty fathoms deep. M. de Lesseps and Roudaire, with their staff, ascended the river Melah a distance of fifteen kilometers, and ascertained that both its banks are formed of compressed sand, without a vestige of rock. This sand, resembling the compressed sand of the Bitter lakes and the Suez Canal, yielded the following analysis:

|                              |        |
|------------------------------|--------|
| Clay.....                    | 66.00  |
| Iron peroxide.....           | 2.00   |
| Calcium carbonate.....       | 9.00   |
| Magnesia.....                | 3.60   |
| Sodium chloride.....         | 3.40   |
| Calcium sulphate.....        | 5.90   |
| Water and carbonic acid..... | 20.00  |
|                              | 99.00* |

The borings which M. Roudaire has undertaken, over a length of 100 leagues and a circumference of 500 leagues, will

\* The sum of the above is actually 109.90, but we have given it as reported by M. de Lesseps.

occupy six months or more, and not till this work is completed can an estimate be made of the cost of letting the sea into the basins of Tunis and Algeria. The French Chamber has provided for the work of leveling, and has appropriated 40,000 francs to meet the expense of the borings, with the promise of additional assistance. Besides detailing one of the officers of his palace to accompany M. Roudaire with an escort of soldiers, the Bey of Tunis has ordered all government officials to afford every possible assistance to the French expedition. At a meeting of the Academy held December 30th, M. de Lesseps read a letter from M. Roudaire communicating the fact that the borings were commenced at the summit of the ridge between the basins and the sea, and although a depth of 18 meters had been reached, nothing but sand and water had been encountered. A subsequent communication from Captain Roudaire, dated Cabes, January 30th, 1879, states that at the summit boring, after the marls had been penetrated to a depth of forty meters, a thin stratum or bank of limestone was reached. This was regarded as presenting no serious obstruction because of the sharpness of its dip toward the north,—a fact which was ascertained by borings south of the summit. At the above date borings at the Gulf coast and by the River Melah at Oudref had been completed. Although in each case a depth of ten meters below low water was reached, nothing was encountered except sand and clay marls. A boring in the *chott* of Hamesmet pushed to a depth of two meters below low tide revealed no obstructions. At a point midway between the sea and the *chotts* pure water was found, obviating the expense of transporting drinking water during the preliminary operations. The cheapness of labor in the desert will contribute greatly to the success of the enterprise. Bands of Arabs coming from all quarters have applied to Captain Roudaire for employment, asking but 90 centimes per day. Just how far the Tunisian sea will extend toward the center of the desert, cannot, at this stage of the enterprise, be conjectured. Whether it will be possible to effect a connection between it and the great depression of El Juf is unknown and doubtful. Should it extend as far inland as M. Roudaire contemplates making borings, namely, one hundred leagues, its southern limit will still be about one thousand five hundred miles from Timbuctoo, or about twice the distance of Timbuctoo from Port St. Bartholomew.

The importance of flooding the Sahara and opening water communication with Soudan, from other than merely commercial considerations, cannot be estimated. In 1872, several authorities, among them Professor Berlioux of Lyons, estimated the annual export of slaves from Africa, including the destruction of life during transit, at upward of half a million. According to Sir Bartle Frere, the Superior of the Mission Convent of Central Africa fixes the annual (in 1872-3) drainage of human life from Africa, consequent upon slavery, at 1,000,000 lives. Lieutenant Young, writing from Lake Nyassa in 1876, describes the long lines of bleached human bones which he saw stretching toward the north-east, and states that the ground was covered with thousands of skeletons which mark the track of the slave-driver. Is it not to be hoped that the opening of Africa would strike a blow, both final and fatal, to this horrible trade? Would not the introduction of a Christian civilization into this vast territory be one of the most magnificent missionary enterprises recorded in history?

The flooding of the Sahara promises to interest the antiquarian and historian as well as the merchant and philanthropist. Both the British and French ministers to Morocco have recently called attention to a collection of ancient manuscripts deposited in the town of Tishit, 300 miles north-west of Timbuctoo. A sculptured obelisk covered with what are regarded as Lybian characters stands solitary in the desert, not far from the north-western extremity of El Juf. Whether the libraries of Tishit are Punic, containing the history of ancient Carthage, or Arabic, reflecting the wisdom of that enlightened people who, in the eighth century, carried science to a perfection which was not attained in Christendom for eight centuries subsequently, it matters not, as in either event their discovery would prove a rich acquisition to literature.

Prior to the execution of the grand scheme which will transform El Juf into a sea and cause the surrounding desert to "blossom as the rose," certain preliminary steps are necessary. Some of these have already been taken by Mr. Mackenzie. First was the establishment of a harbor and trading-station at Port St. Bartholomew on the coast opposite the Canaries, and distant only a few miles from Cape Juby, the point at which the waters are to be admitted to the basin of El Juf. The native chiefs were found very friendly and willing to make any

desired concessions, provided trade should be opened with them. Mr. Mackenzie has also marked out a new route leading from Port St. Bartholomew to Timbuctoo, distant only 800 miles, being 1,200 miles shorter than any other route leading from the coast to Timbuctoo. This line of communication, known as the "Wadan Route," skirting the western and southern limits of El Juf, besides being so much shorter than all others, has the advantage of having forty-two excellent stations, and what is far more desirable, passes through the territory of a friendly and commercial people, who pledge themselves to further and protect the interests of trade.

Mr. Mackenzie estimates that the establishment of the station at Port St. Bartholomew will soon increase the foreign commerce of Timbuctoo from \$20,000,000 to \$60,000,000 per annum. So, even if the enterprise to which this is auxiliary is never carried to success, at least a new route to the center of Africa has been established.

Although the basin of El Juf has been sufficiently examined to afford assurance that its submergence will not disturb the residence or rights of any of the inhabitants of the desert, but on the contrary visit untold blessings upon the vast region which environs it, still Mr. Mackenzie deems it necessary that a thorough survey of its entire boundaries and depth should be made

prior to the admission of the sea. M. de Lesseps, in his recent visit to Tunis and the adjacent desert, found that the elevation of the oases in the northern Sahara ranges from thirty to forty meters above the level of the Mediterranean, while the desert itself is considerably below sea-level. The work of exploring thoroughly so large a district as El Juf, however, can only be accomplished after the confidence and co-operation of the natives have been gained through the commercial intercourse which will spring up with the opening of the "Wadan Route."

As Mr. Mackenzie has made the preliminary arrangements for putting Port St. Bartholomew into communication with Timbuctoo, we may look for the completion of his magnificent scheme and the consequent opening of Africa to commerce and civilization at no distant day. Nor do we hope for anything less than success for the French expedition. Either of these audacious movements may by one bold stroke solve the mystery of the great continent and earn for its author the gratitude of the world of science.\*

\* Obligations are hereby expressed to Lieutenant-Commander Francis M. Green, U. S. N., of the Hydrographic Office, Washington, who, at the instance of Professor Spencer F. Baird, has furnished for this article valuable material relative to the French expedition.

## EDISON'S INVENTIONS. II.\*

### THE CARBON BUTTON AND ITS OFFSPRING.

NOT the least curious in the analytical study of Mr. Edison's numerous inventions is the readily observable peculiarity that the most important of them are the offspring or natural outgrowth of parent germs involving the discovery of previously hidden properties of nature, on which they depend and by which they are rendered susceptible of classification. The electro-motograph, treated of in the last paper, was an illustration in point. There the parent discovery or germ was the fact that the passage of an electric current through a substance saturated with certain chemicals diminished the friction normally existing between the surface of such substance and the electricity-conducting

metal resting upon it. On this principle Mr. Edison constructed his automatic telegraph, which transmits telegrams at the rate of fifteen hundred words per minute, and devised the application to lessen the friction of machinery, the appliance for magnifying and reproducing sound electrically transmitted from a distance, and the apparatus for increasing the speed of telegraphic transmission over long ocean cables. From other beneficent scientific germs, as we shall see, he has deduced various other valuable practical applications.

This peculiarity is noticeable in the "carbon button," which is the generic title Mr. Edison has given to the various substances