diameter. The vertical angle irons, thus arranged conformably to the generatrices of a cylinder, constitute what may be called the central "core" of the globe, and which carries a special ring to which the pivot is bolted.

Twenty other semi-meridians, formed simply of a curved angle iron, are interposed between the others. They are fixed upon parallels and extend to the extreme parallels. All the meridians are provided with a furring of wood.

These meridians and parallels collectively constitute the framework of the sphere, which is extremely light.

The pivot is of iron, and its point is of steel. It revolves in a cast iron bearing with a bronze bushing. The bearing is supported by a frame with a square base formed of four uprights crossbraced by angle irons which are connected with each other by flat and angle iron diagonals. This frame carries the measuring apparatus designed to give the sphere its rotary motion, and which consists of two hand wheels and a pair of bevel wheels that transmit motion, through the intermediate of gearing, to a cogwheel bolted to the central core of the sphere.

The gearings have been so calculated as to allow the sphere to be revolved by one person.

In order that the axis of the globe may be kept perfectly vertical during the maneuvering, there are arranged at the angles of the supporting frame four rollers, which, in revolving, bear against a ring formed of U iron and fixed to the central core.

Surface of the Globe.—The surface of the sphere is formed by the juxtaposition of 355 strips of cardboard all curved uniformly in conformity with the spherical surface of 6'36 meters radius, and cut into curvilinear trapeziums of which two of the sides are meridians and the other two parallels.

The moulding of each piece was done with the utmost accuracy according to an outline made upon a spherical mould. Each piece of cardboard is coated with a mixture of Meudon white and glue size. The coating, from 3 to 4 millimeters in thickness, was laid on in several coats, spread out with a curved template, dried in a stove, and then pumiced. This mode of manufacture, which appears quite simple at first sight, nevertheless required great care on the part of Mr. Ikellmer, to whom this part of the work was intrusted.

The pieces thus formed are fixed upon wooden supports which are screwed to the furring of the meridians.

Painting.—The globe is painted in oil, the paint being applied directly to the cardboard pieces before mounting.

In addition to the representation of the continents, the relief of the earth, and the watercourses, there will be shown the lines of navigation, railroads, submarine cables, the depths of the ocean, the currents, the tracks of the voyages of celebrated explorers, etc.

In order to give an idea of the precision and care applied in the execution of this work, we shall follow, in their sequence, the different operations that had to be performed.

In the first place there was laid out on tracing paper an outline corresponding to each piece of cardboard, and in the preparation of each outline the best maps and the most recent documents that geographical science possesses were consulted. These outlines were stretched upon curved boards, which served as drawing boards. On them were traced the contour and the division in degrees. The sketch finished, the details were transferred to the cardboard by means of transfer paper of different colors.

It was upon these outlines thus reproduced by transfer upon the cardboard that the painters exerted their talent, and taxed their ingenuity to render sensible to the spectator's eye, through effects of light and shade, the reliefs of our planet—bringing into prominence, by light colors, the high plateaux, and showing the deep valleys by vigorous tones, while at the same time preserving the relative importance of each, and selecting for each region the shade that best becomes its general aspect. The ensemble of the color is most happy, and possesses a certain freshness that pleases the eye and impresses it agreeably.

The Building.—The pavilion for the globe is situated on the side of Suffren Avenue, between the Palace of Liberal Arts and the Children's Palace. It consists of six iron trusses of extreme lightness, connected by metallic girders and trimmers. These corners of angle iron and iron plate interties, arranged spirally, serve as supports to a helicoidal gallery ingeniously arranged in such a way as to permit visitors to see every part of the globe by an easy descent from the gallery to the pit beneath the Antarctic pole.

The trusses are provided with brackets that carry the interior helix. These trusses are assembled at the top by an angle iron and iron plate ring surmounted by a cupola. The sides of the building are of wood, with large windows reaching down to the foundation wall.

The forepart of the building consists of two towers and a central bay. The interior of the towers is so arranged that a staircase can be put in one of them, and an Otis elevator in the other, which latter will carry the visitors to a gallery whence they will get their first view of the globe. From the gallery starts the spiral that permits of seeing the continents, save the polar regions, more in detail. To see these last named regions, a threeway footbridge is provided, one of whose branches starts from the gallery and the two others from the helix.—*Le Genie Civil.*

THE GREAT DESERTS OF THE EARTH.

By JOSEPH F. JAMES, M.G.

MR. ALFRED WALLACE, in his interesting book on "Island Life," considers it probable that the present ocean basins and land masses have occupied nearly their present positions since very early in geological history. He shows that the average elevation of the land and the average depth of the sea is such that it is extremely improbable that at any period in the history of the earth were there any oceans comparable in depth to the Atlantic or Pacific where the continents now are. That there were fluctuations in size is probable; and that the continents have gradually increased in extent is also likely; but it may be considered, for all practical purposes, that the position of the land and water masses is permanent.

Investigation of the general arrangement of mountains and plains on continents brings several facts into prominence. First of these is that the margins of great

land masses are generally occupied by mountain ranges of greater or less extent; second, that the greater mountain range is nearest the larger ocean; and, third, that the continent between the two mountain systems is occupied by more or less level plains, plateaux, or deserts. Take the South American continent as an example. The great range of the Andes follows the western shore of the continent at an average distance of only fifty miles, facing the basin of the Pacific, which stretches westward for ten thousand miles. The eastern border of the continent bears the smaller chain of Brazilian mountains, facing the Atlantic ocean, less than three thousand miles in extent. The interior of the country is occupied by the vast valley of the Amazon, a nearly level plain extending two thousand miles from east to west, and stretching almost from the Caribbean Sea to the plains of Patagonia. In this instance the interior plain is fertile. For though dried up in summer, both at the north and south, in the season of rains it produces an abundant vegetation, and is capable of supporting immense herds of horses and cattle. The valley of the Amazon proper is not subject to these changes, but preserves an aspect of perpetual verdure which cannot be paralleled outside of the tropics. Examination of other continents reveals similar features—ranges of mountains near the shores, plains of one character or another between the two.

We are concerned on the present occasion with none but those barren wastes which often occupy vast areas of land known as deserts; places where vegetation is generally absent, and where, if found, it presents peculiar features; where sand is the prevailing soil; where heat or cold, and sometimes both, contend for mastery; and where many a human being and many a beast of burden has lain down to die. The Arctic zone has claimed a large quota of human beings, but the tropics has far surpassed it in the number of its victims. In the one case counted by hundreds, in the other they mount up into the thousands.

The desert region of South America is one which was, perhaps, known to Europeans long before any other in the western world. The Puna, as it is called, occupies a tract of land extending for three hundred and fifty Spanish miles between the Andes and the Cordilleras at an elevation of twelve thousand feet. It spreads over nearly the whole of Peru, from northeast to southwest, through Bolivia, and eastward into the Argentine Republic. The climate is rigorous. Winds blow from the west and southwest nearly all the year round, bringing from the snow-capped Cordilleras icy cold weather. During four months of the year the storms are accompanied by thunder, lightning, and snow. The average height of the thermometer in the cold season (strangely called summer because it seldom snows) is, during the night, 12° F., and at midday about 50° F. In winter, or the warm season, the mercury seldom falls below freezing during the night, but at noon it is only about 45° F. The temperature, however, is so uncertain that it will sometimes vary 40° in a few hours. This change is more severely felt on the fall of temperature, as it is accompanied by keen, biting winds which cut the face and hands, but which have so remarkable a drying effect that in a few days a dead body is converted into a mummy, and no sign of decomposition is to be observed.

A feature not the least remarkable of all the meteorological conditions of the Puna is the occurrence of alternate streams of warm and cold air. After traversing a space where biting winds prevail, there comes a warm atmospheric current which varies in width from two or three paces to several hundred feet. These streams run parallel to each other, and travelers sometimes pass through five or six of them in a few hours. They seem to be most frequent in August and September, and generally follow the direction of the Cordilleras. Von Tschudi states that he once traveled several leagues through a succession of these currents of warm air, none of which exceeded twenty-seven paces in width. Their temperature was 20° F. higher than the adjacent atmosphere. It would seem that they are not temporary currents, for the inule drivers can often foretell about where they will be encountered.

The aspect of the Puna is dreary and monotonous. The ground is covered by yellowish-brown grass, never freshened into green. A few trees are scattered here and there, which serve as fuel or to make the huts of the Indians. Only a single plant can be cultivated with any success, a plant with a tuberous root, possibly a species of *Tropaeolum*. Barley does not ripen, though planted and cut for fodder.

The animal life is comparatively abundant. Here lives the mountain camel, the llama, with its congeners the alpaca and vicuña. Several species of deer, the chinchilla, a species of fox, the cougar, and a black bear frequent portions of this desert tract. Among the birds the condor is the best known, and this bird, with a stretch of wing of from twelve to thirteen feet, soars high above the loftiest peaks and builds its nest in the most inaccessible parts of the Andes. For a long time extravagant stories were told of it. It was the roc of Sindbad. It was invulnerable to a musket ball. It carried off sheep and calves and even young children to feed its voracious young. These are but fables. It lives nearly altogether upon carrion, only attacking live animals when impelled by hunger. It can carry in its claws and beak a weight of from eight to ten pounds, and being very fierce has been known, when in captivity, to attack a child and so injure it about the head as to cause its death.

Another desert region in Peru stretches along the shore of the Pacific for a distance of twelve hundred miles, varying in width from eight to fifty miles. Chains of small hillocks extend westward from the mountains, gradually decreasing in height toward the sea, or ending in abrupt cliffs. A number of small rivers find their way from the mountains to the sea, irrigating patches of ground. Where the influence of these streams is not felt, a fine light yellow sand covers hill and dale. Strong winds raise great clouds of dust. These sometimes form pillars eighty and one hundred feet high, moving most capriciously and with great rapidity over the plain. The sand hills raised by the wind are often without any firm base, and so rapidly is the aspect of the surface changed, that what was one day a plain covered with conical hills is the next a level expanse without any considerable elevations.

The summer commences in November. The rays of the sun, reflected back from each individual quartz grain, exert a blinding, scorching influence. Men double up like hedgehogs to escape the glare. No plant

takes root, no animal finds food upon the arid surface. No bird, no insect is to be seen, and only in the very loftiest regions the condor floats on daring wing. Only where ocean and desert meet is any other life to be found. Carrion crows feed on the dead marine animals; seals enliven the rocks, crabs burrow in the sand, and certain coast birds find food in the fish and mollusks of the shore.

The scene changes in May. Then a thin veil of mist overspreads the shore. It gradually increases in density, is heaviest in August and September, and disappears in October. This is the winter season. In May and in October the mist rises from 9 to 10 A. M. and disappears at 3 P. M. During August and September it lies for weeks at the surface, never forming rain proper, but only a thick fog or drizzle. The natives call it the *garua*. The average height to which it extends is about one thousand feet. It is known only within a few miles of the shore, and beyond here it is superseded by heavy rain. The boundary between the region of mist and the region of rain is so well defined that on two adjoining plantations one half is watered by rain and the other half by the *garua*; the boundary line is marked by a wall! When the mists set in, the hillocks undergo a magical change. Vegetation overspreads the soil; horses and cattle for several months find abundant pasturage. Though there is no water, cattle do not seem to suffer from lack of it, for they are always in good condition. This desert has of late years been partially subdued by man, and now a railroad crosses it from the coast, penetrates the mountains, and terminates at Lake Titicaca, 13,000 feet above the sea.

Across the Atlantic, on the African continent begins a series of deserts which extend with little interruption to the boundaries of China. The first of these is the greatest desert in the world, known under the name of *Sahara* or *Zahara*. The Arabian geographers were the first to apply the name. These writers also called it *Sahara-belama*, or the "waterless waste," or *Sahara-ul-aski*, the "complete waste." Beginning at the Atlantic Ocean, this desert extends eastward for a distance of 3,100 miles, broken only by the oases formed by the Nile, and reaching to the Red Sea. The average width is six hundred miles, so that it is equal in area to two-thirds of Europe. It has but one season, that of summer, burning and merciless. While the mean altitude is estimated at two thousand feet, there is one part near the northern boundary one hundred and sixty-five feet below the level of the Mediterranean, and other places on the south and east where the ground rises into plateaux and mountains of sandstone and granite reaching an elevation of six thousand feet and more. In the center stands the mountain Djebel-Hoggar, the top of which is covered with snow three months of the year, while from December to March its sides are furrowed by streams which flow some distance and are lost in the sand. This group of mountains forms the dividing line between the eastern desert, or Sahara proper, and the western portion, known as the Sahel. "The Sahel," says Reclus, "is very sandy. Throughout the greater part of its extent the soil is composed of gravel and large-grained sand, which does not give way even under the foot of the camel." Sometimes it forms hills heavy enough to resist the action of the wind, but in other cases it is so fine and small that the constantly blowing trade winds carry it in clouds to the southwest, encroaching upon the channels of the Niger and Senegal and driving them from their courses. At the west it also encroaches upon the ocean, forming such extensive banks that the Arabs who go to collect the waifs and strays from wrecked vessels can safely venture out several miles from shore. It is also stated that at times the sand so fills the air several miles out at sea that the weather seems hazy. Parts of the desert on the east are sandy also, but the main portion is occupied by plateaux of rock or clay, or groups of mountains.

Scattered in long lines over the desert are numbers of oases, little tracts of land watered by springs of water which gush out of the ground or descend from some group of mountains. Here date palms, apricots, peaches, and other fruits ripen, and caravans stop for rest and refreshment. Every speck of space is utilized, the huts being built on the most unproductive spots. Date palms supply the greater part of the food of men, camels, horses, and dogs.

Immense tracts exist where these oases are not found. Here the path taken by the caravan follows a straight line to its destination. Sometimes the faint footmarks are covered with sand, and then the compass, an occasional hill, a bush, and often a heap of bones indicates the way. Vegetation is rare. Those plants that exist at all are spiny or aromatic. Wornwood, thistles, and the thorny mimosa are the principal kinds. Ants, scorpions, lizards, and vipers constitute the animal life. Flies accompany the caravan for a few days, but are soon killed by the heat, and even the flea finds it impossible to exist. Radiation from the white or red sand dazzles the eye, and all nature looks somber. The mirage displays cities, palaces, groves of palms, lakes and streams of water with a vividness scarcely to be credited. When the wind blows, the face and body are beaten by grains of sand which prick like needles. The wells scattered over the desert are sometimes good, sometimes bad, generally the latter. Sometimes the wells fail or are missed by the guides, and then each drop of water is guarded as a jewel of untold price.

Although terrible stories are told of whole caravans and whole armies being overwhelmed by the sand, and though the bleaching bones of men and camels often line the track of caravans for miles, generally speaking companies led by experienced guides, and protected by treaties from the depredations of tribes through whose country they pass, arrive safely at their journey's end. They experience little suffering except that caused by the bad water, the excessive heat of the day and the cold of night. The air being so entirely destitute of aqueous vapor causes excessive radiation from the soil as soon as night sets in, so that burning days are followed by cold nights. Not a year passes without ice forming on the ground, and white frosts are frequent. A difference of 129° F. has been observed between the lowest (24° F.) and the highest (153° F.) temperature, and the real difference between extremes of heat and cold is estimated at 144° F. Bayard Taylor says that he found he absorbed so much heat during a long day's ride in the desert that, as evening came on, the temperature of his skin commenced to rise, until at night his body glowed like a hot coal.

The eastern portion of the desert, known to the Arabs as the *Atmoor*, is the ideal desert. "This," says General Colston, "consists mainly of hard gravel plains, diversified by zones of deep sand, rocky ridges, sometimes of considerable altitude, and rugged defiles. It is absolutely destitute of all vegetation, and consequently of animal life. Only the ostrich and hyena cross it swiftly by night, and the vulture hovers over the caravans by day. Not a tree, not a bush, not a blade of grass, relieves the glare of the sunlight upon the yellow sand." "Within the limits of Egypt and the Soudan these desolate atmoors extend over three-quarters of a million of square miles, never trodden by the foot of man. Only a few caravan trails cross them in their narrowest part, with scanty wells at long intervals, and the necessities of trade can alone account for their being penetrated at all. They are like oceans, where caravans pass each other in haste, like vessels at sea. The marches are perfectly terrible, and yet it is worse to halt during the day than to keep in motion, for the heat makes sleep or rest impossible even under canvas. . . . The air that blows feels as if it had just passed through a furnace or a brick kiln. Over the plain it quivers visibly in the sun, as if rising from a red hot stove, while the mirage mocks your senses with the most life-like images of lakes, ponds, and rippling waters."

Like the llama in Peru, the camel is the beast of burden of the Sahara. Without this animal these wastes would be impassable. He seems to be formed for this home, and thrives better here than anywhere else. His foot is broad, soft, and flat, enabling him to travel over soft, deep sand where the horse would soon sink down exhausted. He lives on almost nothing, the scanty desert herbs and the thorny mimosa being his favorite food. These, together with the inestimable quality of being able to travel for several days without water, make him the most valuable beast of burden in the world.

The Nile valley may be considered as nothing else than a long oasis in the midst of the desert. The life of this oasis is the Nile, which after centuries of speculation and exploration has had its secret wrested from it. For a distance of seventeen hundred miles above the delta, the river receives no tributaries. At this point two streams, the White and the Blue Nile, join to form the main stream. The latter of the two has many branches having their sources in the mountain regions of Abyssinia. The heavy summer rainfall causes torrents to rush down the sides of hills and mountains, carrying great quantities of soil with them. The White Nile, on the other hand, has its source in the great Victoria Nyanza, lying under the equator. The arable land of Egypt covers an area of about ten thousand square miles, which is made to support seven or eight million people. Where the irrigating waters cease the desert begins, and its limit is as sharply marked as a gravel walk across a greensward.

From the eastern side of the Nile the desert extends without interruption to the shores of the Red Sea, and across this begins the great *Arabian Desert*, a tract not well defined, and but little known. The whole of Arabia has been referred to as a desert and as the abode of the blest alternately; as a land of sand and rock, and a land of spice and incense. In parts of the peninsula both descriptions will apply, for while the whole of the coast is lined with mountain ranges of greater or less elevation, and while on the inside there is everywhere a strip of desert, the central portion of the country is a high plateau, with mountains averaging five thousand feet in height, having numerous springs which make fertile valleys. Roughly, the central plateau constitutes one-third of the area of the peninsula, the desert another third, and the coast ranges the rest. The great desert region is at the south, a sandy waste covering about fifty thousand square miles, only dotted here and there with a few stunted bushes or dwarf palms. Its surface is ribbed by huge waves of sand having a general north and south direction, though the prevailing wind is from the east. But these main waves are again crossed and intersected by others, less regular, produced by variable winds. Sand columns, such as overwhelm caravans in the Sahara, are here unknown. Heat, hunger, and especially thirst, the traveler must contend with. The first is fearful both by night and by day. Some parts of the tract have never been crossed by either Bedouin or Frank. On the north and east are smaller but still formidable deserts. In places the sand is said to be four hundred or five hundred feet deep. In the north, as in the south, are long parallel ridges of sand, like waves of the sea. They have been accounted for by the rotation of the earth, the sand being carried forward particle by particle, while the solid rocks beneath are immovable.

The author of "Eothen," traveling from Jerusalem to Suez, says of the northern part of the desert: "As long as you are journeying in the interior of the desert, you have no particular point to make for as your resting place. The endless sands yield nothing but small, stunted shrubs; even these fail after the first two or three days, and from that time you pass through valleys dug out by the last week's storm, and the hills and the valleys are sand, sand, sand, still sand, and only sand and sand again."

One of the characteristics of the Arabian and other Asiatic deserts is the simoon. This is a violent wind, described by Palgrave as "a peculiar condition of the atmosphere, resembling in all essential points a cyclone. As in the cyclone, the central space, or the simoon itself, is calm, but is occupied by a gas unfit for respiration; while around this as a center, slowly traveling on, there eddy violent gusts of heated air, like those of a furnace, though it is not to them, but to the comparative vacuum which they surround, that the simoon owes its suffocating qualities. It approaches slowly amid the whirl of air currents which precede it for some distance. Its violet color announces it when actually near. During its presence the only chance of preserving life till the mephitic vapor has passed over is found in covering the face with a cloth and lying prone on the sand, thus to inhale what little atmospheric air still exists in the upper ground stratum." The passage of the column lasts from two to ten minutes. The feeling in the chest is like suffocation, and the limbs feel as if molten iron were being poured over them.

A very large part of Persia to the north of Arabia, and the country to the south and east of the Caspian Sea, is occupied by another desert tract. Vegetation about here is said to be so rare that one may travel three hundred miles and see but a single tree. This one specimen

is so revered by the wandering natives that they often go far out of their way to hang rags as offerings upon its branches. In Persia the *kavir* or salt desert often extends for a hundred miles in length and stretches out for twenty-five or thirty miles on either side. Sometimes the ground is in ridges, looking as if it had been plowed, left fallow for some time, and then glazed with a coating of salt clay. Riding over this a continual crackling is heard, caused by the horses' hoofs breaking through the glazed surface. "Again the whole surface seems rotten, and the horses' feet sink deeply into it, causing the salt to show white on the surface. Sometimes the solid earth gives place to sand dunes, the road leading up one and down another, and with the soil so loose that the horses sink to their fetlocks or even to their knees."

The region about the Caspian Sea is an arid one, with but few charms to attract, and as one travels eastward the country becomes gradually worse until the Sahara of Asia, the *Desert of Gobi*, is reached. This immense tract of land extends over eighteen hundred miles from west to east and has an average width of five hundred miles. It is a high plateau, with an elevation of about five thousand feet above the sea, and lies between two high ranges of mountains, the Himalaya and the Altai. It is a waste of sand and rock, mostly incapable of cultivation or even of supporting vegetation. The oases are few in number, and contain only a small amount of grassy vegetation, and in a distance of four or five hundred miles there are only five trees known. A few agricultural operations are carried on along its borders during the three months of the year which constitute the summer. During the rest of the year the weather is cold. Swept by icy winds from Siberia on the north, it freezes nearly every night and often during the day. The mercury often sinks to 30° or 40° below zero, and sudden changes are frequent.

The general aspect of the desert is described as extremely desolate. Abbe Hue is one of the few who have penetrated into the inhospitable region, and from him we may glean a general idea of its aspect. "Which ever way you turn," says he, "you find nothing but rocky ravines, hills of mud, and plains encumbered with fine movable sand, which the wind sweeps about in all directions. The only pasturage consists in a few thorny shrubs and thin heaths of a fetid odor. Here and there you find a little thin, brittle grass, which sticks so closely to the ground that the animals cannot browse it without scraping up the sand at the same time."

Immediately to the north of the mountains inclosing the Thibetan plateau the desert assumes its most terrible aspect, "being covered," says Williams (Middle Kingdom), "with dazzling stones and rendered insufferably hot by the reflection of the sun's rays from these and numerous movable mountains of sand. Nor is the climate more endurable in winter. The icy winds of Siberia, the almost constantly unclouded sky, the bare saline soil, and its great altitude above the sea, combine to make Gobi one of the coldest countries of Asia." A Chinese author has well expressed its desolation, for he says, "There is neither water, herb, man, nor smoke; and if there is no smoke, there is absolutely nothing."

The great Yellow River is the dividing line between the desert and the fertile provinces of China. On the western side of the river is a range of mountains, and in the ravines are heaps of mica and stones, broken and often pulverized. The rocks are incrustated with shells and *lebrils* resembling sea weeds, and are cut and worn into holes in all directions, as if they had been subjected to the action of gigantic worms. This peculiar condition of the rocks is probably due to the action of sand blown by the winds from off the desert.

Bordering one side of the desert are the Alechan Mountains, described as being formed of sand so fine that it will run through the fingers like water. Here there is absolutely no trace of vegetation. Insects ornament the surface with their tracks, for even that made by an ant may be perceived. The yellowish color of the Yellow River, or Hoang-Ho, is due to the sand forming these mountains, for above them the waters are pure and limpid.

Passing, in imagination, across the Malay Archipelago and the Indian Ocean, turn and take a glance at the desert region of Australia, of a size nearly equal to the whole of Europe. This vast island contains tracts of desert which rival Gobi or the Sahara in their desolation. In proportion to their extent they have been the most difficult of all to explore. The few daring travelers who have crossed these deserts in safety draw pictures of horror. One party traveled for seventeen days, covering three hundred and thirty-seven miles, without finding a drop of water. A shower of rain then fortunately fell, and the party were saved. A second time seventeen days passed without water being found, when a water hole was discovered, which proved their salvation. Danger from natives is added to danger from heat and from thirst. Vegetation is confined to spiny shrubs, a few trees, and dry grass.

In a few words, as stated by one of the explorers, the center of Australia contains "half a million square miles (about one-fifth of the entire area of the continent) which offer nothing but barrenness and death to the bold invaders. The southern part of this wilderness is dotted with hills of soft, white, yielding sand, thickly clad with spirifex, scrub oak, and other low shrubs, and an occasional group of eucalyptus. The northern portion of this desert is almost entirely destitute of even this useless vegetation, and its sands hills have not even spirifex to relieve their arid glare. Frequently the intense rays of the sun in summer set the parched foliage of the wilderness in a blaze, and devastating fires prevail, giving rise to hot winds, which make their presence felt in the outlying settlements." All our knowledge of this desert tract has been obtained in the wild race for life of travelers across it. It is possible that in the future grass may grow and sheep may browse where now sand and sun contend for mastery.

Leaving now the old world, with its circle of desert tracts, we cross the Pacific Ocean and enter our own country to view in a short space the Great American Desert. This is, it is true, a term of very vague application, and must be restricted to a smaller area than that to which it was originally applied. Consult any of the earlier maps of our Western country, and large areas will be found marked deserts where now are prosperous farming communities or extensive cattle ranges. Nevertheless the term may be aptly applied to large portions

of Nevada, Utah, Arizona, New Mexico, and Southern California. The Colorado and the Mojave deserts in the latter State, though deserts in every sense of the word, are limited in area, and must give place to the larger desert which occupies the other four States or Territories. Government explorations have made this part of the world familiar to us, and it is in one of those usually dry-as-dust reports that we find a most vivid picture of the Great American Desert. Eliot Lord, in his report upon the Comstock Lode, says:

"The cloud banks blown overland from the Pacific are thrown in masses against the bristling teeth of the Sierra Nevada. Repelled at every point, they break in rain, snow, and hail among the mountains. Winter storms tear their way sometimes through this unyielding barrier and bury the hill tops beyond under eddying snowdrifts, but a covering is rarely cast over the deformity of the deserts below. Looking eastward from any bare crag above the tree belt, the eye sees no end to these desolate wastes, and beyond the range of vision they stretch unbroken for hundreds of miles. A few shallow rivers, fed by the mountain snows, wander in narrow beds through the canons and valleys, vanishing at length in alkaline sloughs or pouring their wasted streams into brackish lakes. Broken fringes of green mark their winding courses—the only relief to the somber tints of the landscape."

Viewed from a distance, the repulsive features are softened in tone. A velvety brown appears to cover the rocks and hills; white clay banks gleam like silver. Over all is a sky of the clearest blue, flushed with the splendor of noon or glittering coldly with stars.

"Descend into the midst of the desert and look closely around. The soft brown slopes are changed to scarred and naked rocks, the shining lakes to beds of alkaline earth seamed with innumerable cracks, and the gray plains to wastes of sand dotted with clumps of sage brush. Here and there at long intervals stalks of bunch grass thrust their stiff blades out of the arid soil, covered often with clinging crystals of salt which sparkle like frost in the sunlight. Dusky lizards dart about among the blackened rocks of the isolated ridges, and lizards with yellow backs sprawl on the hot sand. A little flock of sparrows may hover about some mountain spring, a coyote sometimes ambles over the hills, and jack rabbits scurry through the sage brush in ridiculous alarm, but the oppressive stillness is rarely broken by the movement of anything with life. Nature seems to sleep, except when the brooding air is stirred by the passage of clouds and columns of feathery dust, borne by eddying whirlwinds over the desert." "It was over this dreary land that the Mexican guide of Fremont pointed, from the mountain pass at the head of the river San Joaquin. 'There,' said he, 'there are the great llanos. There is neither water nor grass—every animal which goes out upon them dies.'"

This description applies to many hundreds of square miles of our Western territory. The great basin region is one of rock, sand, and alkali, with a scanty growth of sage brush and a little animal life. It is crossed by numerous railroads, is the seat of great silver mines, and the grave of hundreds of luckless emigrants. For in the days of gold excitement in California, many a wagon was abandoned, many an animal lay down to die, many an emigrant perished of hunger, or of thirst, in the Humboldt Desert.

Having now passed in review the main desert regions of the earth, let us devote some little space to the question of the origin of the deserts. For some the answer is simple. Meteorological conditions have had much to do with them. The Puna and the coast desert of Peru can be ascribed to the presence of the Andes and to the direction of the prevailing winds. The rainy winds of the northern half of the continent of South America come from the Atlantic. Laden with moisture, they strike against the high peaks of the Andes, and they are forced to ascend. Here the vapor becomes condensed into clouds, which break as rain and deluge the eastern slope of the mountains. Crossing to the other side, they descend as dry winds, and continue their course to the westward. At the southern end of the continent, on the contrary, the rains come from the Pacific. Here the moisture-laden winds strike the Andes, drop their rain on the western slope, and travel eastward over Patagonia as dry winds.

The desert of Gobi, in Asia, owes its existence to a similar cause. In this case the Indian Ocean supplies the moisture, which is all wrung out by the Himalayas, so that the winds descend to the north as dry ones. So, too, is it with the deserts of Utah and Nevada. Here the winds come from the Pacific, and, being robbed of their burden by two successive ranges of mountains, reach the interior as thoroughly dry winds. The case is different with the Sahara. This is in all probability an ancient sea bottom, gradually elevated by volcanic agency. It was thus naturally arid. The westerly winds from the Atlantic lose all their moisture by the hot air from the desert, or else are driven up to the higher regions of the atmosphere. If a high range of mountains, sufficient to stop and condense the moisture from the western winds, was on the eastern side of the desert, its aspect would probably be vastly different from what it is.

The area about the Caspian is also probably the bed of an extensive mediterranean sea. Dr. Carpenter gives many reasons for supposing that at one time the present Caspian was connected with the Arctic Ocean on the one hand and with the Black Sea on the other. A slight elevation of land at the north would cut off its connection with the Arctic; while an increased evaporation, or decreased rainfall, would cause connection with the Black Sea to cease. Then, of course, greater evaporation would cause further contraction and consequent exposure of much land with quantities of salts of various kinds. The Arabian deserts have been stated to be due to the disintegration of chains of mountains, but too little is known of the country to speak with any certainty. The same may be said of the Australian deserts; their cause is not known. Probably they represent, like the Sahara and Gobi, the bed of an ancient sea.

The small, comparatively speaking, Colorado desert in Southern California was probably the ancient head of the Gulf of California. The head was one hundred and seventy miles further north than its extreme northern extension now. The proof of this is to be found in the vast quantities of dead shells scattered over the desert; in the extreme fineness of the soil; in the extent of its depression below sea level, some two hundred and sixty feet; in the evidence of a shore line

found along the mountains bordering it on either side; and finally, in the traditions of the natives, which refer to the presence of a "great water" in which their fathers fished, and upon whose shores they dwelt. The ancient shore line can be seen following all the indentations of the shore at a uniform level for many miles, and plainly marked by a calcareous incrustation extending below but not above the line of shore.

The Colorado River carries down an immense amount of sediment into the Gulf of California. At the time of the existence of the ancient bay, the mouth of this river was one hundred and seventy miles from the northern end and at a narrow part. Detritus gradually filled up the gulf opposite the mouth, so that after a time water only entered the northern extension at high tide. Still later it entered only on the occasion of a river flood and a very high tide, and finally the sea was shut out entirely, and no water replaced that lost through evaporation. Then the lake rapidly diminished in extent, until it finally disappeared altogether. Such may be considered the history of this small and in many senses interesting desert of California.

It would be an interesting inquiry to endeavor to determine the effects of the larger deserts upon civilization. For if we are to believe the author of the "Decline and Fall," the inhospitable features of the great Gobian desert are responsible for the hordes of Huns and other tribes which poured in such an incessant stream into Europe from Central Asia. Such may have been the case, and if so, it was fraught with great importance to the welfare of Europe. Stopped by ranges of mountains or by the warlike Chinese on the east, the way to the west lay invitingly open, a gradual slope for hundreds of miles. Thither they marched, and swarmed like locusts over the fair fields of Central Europe. So too, if we are to believe some, we may look even further back into the "dim corridors of time" and discern the primitive Aryan race, the early ancestors of earth's dominant family, coming into view. They also found toward the west their easiest path, and taking the setting sun as their guide, were first to show that

"Westward the course of empire takes its way."

OTTO PATENT WIRE ROPEWAY.

It is somewhat surprising that so little progress has been made of late years, in this country, in the design and adoption of aerial tramways, the old Hodgson system of single endless running rope, to which the buckets are attached and carried along, being the only one so far employed. These single rope tramways are, from the nature of their construction, limited to the carrying of light loads, and subject to considerable wear and tear; this may partly account for their not having been more extensively adopted.

With the Otto ropeway these drawbacks have been overcome by using fixed ropes, of considerable diameter, to carry the load, and a light flexible endless steel wire rope for hauling it. This plan enables these lines to be carried over wide valleys and rivers and up very steep inclines without difficulty, and permits of an economical transport of large quantities of material. Nearly 300 of these ropeways are now at work, so that there is no longer any question as to their practical utility and efficiency. Single lines on this principle are at work, varying from 100 yards to several miles in length, and spans of over 1,000 ft., with a carrying capacity of 5,000

tons per week, and two to three times this amount on lines arranged with double and triple systems of fixed ropes.

Messrs. Commans & Co., mining engineers, of London, recognizing the great importance of this cheap means of transport, have taken up the manufacture of the Otto ropeway for this country and the colonies. So far, the only section of line they have erected in this country has been the one they exhibited at the late Newcastle-on-Tyne exhibition, and for which they were awarded a silver medal—the highest award given—by the haulage committee. This system of transport, we are convinced, has only to become better known to

be very generally adopted, not only for the transport of mineral, but also for all kinds of goods overland, where the construction of ordinary tramways would be either too costly or impossible. This same system of transport has also lately been largely employed in factories, breweries, etc., for carrying the goods about in the buildings and warehouses, fixed hanging rails being employed in the place of the wire ropes.

In order to give a more clear idea of the capacity and efficiency of these ropeways, we will fully describe an existing line, and have chosen for this purpose one at work at the Gottessegen Colliery, near Antonienhutte, in Upper Silesia. The Gottessegen Colliery, together with the Hugozwang Mine, some mile and three-quarters distant, belong to Count Hugo Henckel von Donnersmarck. The main shaft of the Gottessegen Mine is known as the Aschenborn, that of the Hugozwang as the Menzel shaft. These two shafts communicate with

each other by a gallery some 500 ft. below the surface; but above ground, before the ropeway was built, there was no direct communication. The shafts are joined up to the main Silesian railway system at Morgenroth station by two short branch lines, some four miles in length. The line from the Menzel shaft to Morgenroth station is, however, of a narrower gauge than the main line, so that all the coal from this colliery required to be unloaded into main line trucks, which entailed considerable expense and increased the amount of small coal.

At the Aschenborn Colliery there is a very complete

modern screening plant, capable of treating some 700 tons to 800 tons per day; but the arrangements for screening at the Menzel shaft are somewhat primitive. In order to reduce the cost of transport and loss through breakage of coal from the Menzel shaft, to employ this coal when necessary at the Antonien Ironworks, and to make use of the above mentioned screening plant at the Aschenborn shaft, it was deemed necessary to make some alteration in the means of communication between the two pits. Several schemes were taken into consideration; but, after weighing the advantages of both underground and overground haulage, and careful calculation of the cost, the Otto system of aerial ropeway was finally decided upon as being the cheapest and most suitable.

The line was erected during a very severe winter, and took about six months to erect. Ever since its completion it has been at work without the least in-

OTTO WIRE ROPE RAILWAY, GOTTESEGEN COLLIERY, ANTONIENHUTTE, WESTPHALIA.