Among the Forces eBook

Among the Forces

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WHY WRITTEN

Fairies, fays, genii, sprites, *etc*., were once supposed to be helpful to some favored men. The stories about these imaginary beings have always had a fascinating interest. The most famous of these stories were told at Bagdad in the eleventh century, and were called *The Arabian Nights' Entertainment*. Then men were said to use all sorts of obedient powers, sorceries, tricks, and genii to aid them in getting wealth, fame, and beautiful brides.

But I find the realities of to-day far greater, more useful and interesting, than the imaginations of the past. The powers at work about us are far more kindly and powerful than the Slave of the Ring or of the Lamp.

The object of writing this series of papers about applications of powers to the service of man, their designed king, is manifold. I desire all my readers to see what marvelous provision the Father has made for his children in this their nursery and schoolhouse. He has always been trying to crowd on men more helps and blessings than they were

willing to take. From the first mist that went up from the Garden the power of steam has been in every drop of water. Yet men carried their burdens. Since the first storm the swiftness and power of lightning have been trying to startle man into seeing that in it were speed and force to carry his thought and himself. But man still plodded and groaned under loads that might have been lifted by physical forces. I have seen in many lands men bringing to their houses water from the hills in heavy stone jars. Gravitation was meant to do that work, and to make it leap and laugh with pearly spray in every woman's kitchen. The good Father has offered his all-power on all occasions to all men.

I desire that the works of God should keep their designed relation to thought. He says, Consider the lilies; look into the heavens; number the stars; go to the ant; be wise; ask the beasts, the fowl, the fishes; or "talk even to the earth, and it showeth thee."

Every flower and star, rainbow and insect, was meant to be so provocative of thought that any man who never saw a human book might be largely educated. And every one of these thoughts is related to man's best prosperity and joy. He is a most regal king if he achieve the designed dominion over a thousand powerful servitors.

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It is well to see that God's present actual powers in full play about us are vastly beyond all the dreams of Arabian imagination. It leads us to expect greater things of him hereafter. That human imagination could so dream is proof of the greatness of its Creator. But that he has actually surpassed those dreams is prophecy of more greatness to come.

I desire that my readers of this generation shall be the great thinkers and inventors of the next. There are amazing powers just waiting to be revealed. Draw aside the curtain. We have not yet learned the A B C of science. We have not yet grasped the scepters of provided dominion. Those who are most in the image and likeness of the Cause of these forces are most likely to do it.

THE MAN WHO NEEDED 452,696 BARRELS OF WATER

A man once had a large field of wheat. He had toiled hard to clear the land, plow the soil, and sow the seed. The crop grew beautifully and was his joy by day and by night. But when it was just ready to head out it suddenly stopped growing for want of moisture. It looked as if all his hard work would be in vain. The poor farmer thought of his wife and children, who were likely to starve in the coming winter. He shed many tears, but they could not moisten one little stalk.

Suddenly he said, "I will water it myself." The field was a mile square, and it needed an inch of water over it all. He quickly figured out that there were 27,878,400 square feet in a square mile. On every twelve square feet a cubic foot of water was needed. A cubic foot of water weighs sixty-two and a third pounds. Hence it would require 74,754 tons of water. To draw this amount 74,754 teams, each drawing a ton, would be required. But they would tramp the wheat all down. Besides, the nearest water in sufficient quantity was the ocean, one thousand miles away over the mountains. It would take three months to make the journey. And, worse than all else, the water of the ocean is so salt that it would ruin the crop.

[Illustration: Breaking Waves.]

Alas! there were three impossibilities—so many teams, so many miles, so long time—-and two ruins if he could overcome the impossibilities—trampling down the wheat and bringing so much salt. Alas, alas! what could he do but see the poor wheat die of thirst and his poor wife and children die of hunger?

Suddenly he determined to ask the sun to help him. And the sun said he would. That was a very little thing for such a great body to do. So he heated the air over the ocean till it became so thirsty that it drank plenty of water, choosing only the sweet fresh water and leaving all the salt in the ocean. Then the warm air rose, because the heat had

expanded it and made it lighter, and the other air rushed down the mountains all over that side of the continent to take its place. Then the warm air went landward in an upper current and carried its load of water in great piles and mountains of clouds; it lifted them over the great ranges of mountains and rained down its thousands of tons of sweet water a thousand miles from the sea, so gently that not a stalk of wheat was trampled down, nor was a single root made acrid by any taste of brine.

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Besides the precious drink the sun brought the most delicate food for the wheat. There was carbonic acid, that makes soda water so delicious, besides oxygen, that is so stimulating, nitrogen, ammonia, and half a dozen other things that are so nutritious to growing plants.

Thus the wheat grew up in beauty, headed out abundantly, and matured perfectly. Then the farmer stopped weeping for laughter, and in his joy he remembered to thank, not the sun, nor the wind, but the great One who made them both.

THE SUN'S GREAT HORSES

There was once a man who had thousands of acres of mighty forests in the distant mountains. They were valueless there, but would be exceedingly valuable in the great cities hundreds of miles away, if he could only find any power to transport them thither. So he looked for a team that could haul whole counties of forests so many miles. He saw that the sun drew the greatest loads, and he asked it to help him. And the sun said that was what he was made for; he existed only to help man. He said that he had made those great forests to grow for a thousand years so as to be ready for man when he needed them, and that he was now ready to help move them where they were wanted.

So he told the man who owned the forest that there was a great power, which men called gravitation, that seemed to reside in the center of the earth and every other world, but that it worked everywhere. It held the stones down to the earth, made the rain fall, and water to run down hill; and if the man would arrange a road, so that gravitation and the sun could work together, the forest would soon be transported from the mountains to the sea.

So the man made a trough a great many miles long, the two sides coming together like a great letter V. Then the sun brought water from the sea and kept the trough nearly full year after year. The man put into it the lumber and logs from the great forests, and gravitation pulled the lumber and water ever so swiftly, night and day, miles away to the sea.

How I have laughed as I have seen that perpetual stream of lumber and timber pour out so far from where the sun grew them for man. For the sun never ceased to supply the water, and gravitation never ceased to pull.

This man who relentlessly cut down the great forests never said, "How good the sun is!" nor, "How strong is gravitation!" but said continually, "How smart I am!"

OLD SUN HELP

Holland is a land that is said to draw twenty feet of water. Its surface is below sea level. Since 1440 they have been recovering land from the sea. They have acquired 230,000 acres in all. Fifty years ago they diked off 45,000 acres of an arm of the sea, called Haarlem Meer, that had an average depth of twelve and three quarters feet of water, and proposed to pump it out so as to have that much more fertile land. They wanted to raise 35,000,000 tons of water a month a distance of ten feet, to get through in time. Who could work the handle?

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The sun would evaporate two inches a year, but that was too slow. So they used the old force of the sun, reservoired in former ages. Coal is condensed sunshine, still keeping all the old light and power. By a suitable engine they lifted 112 tons ten feet at every stroke, and in 1848, five years after they began to apply old sun force, 41,675 acres were ready for sale and culture.

The water that accumulates now, from rain and infiltration, is lifted out by the sun force as exhibited in wind on windmills. They groaningly work while men sleep.

The Netherlandish engineers are now devising plans to pump out the Zuyder Zee, an area of two thousand square miles. There is plenty of power of every kind for anything, material, mental, spiritual. The problem is the application of it. The thinker is king.

This is only one instance of numberless applications of old sun force. In this country coal does more work than every man, woman, and child in the whole land. It pumps out deep mines, hoists ore to the surface, speeds a thousand trains, drives great ships, in face of waves and winds, thousands of miles and faster than transcontinental trains. It digs, spins, weaves, saws, planes, grinds, plows, reaps, and does everything it is asked to do. It is a vast reservoir of force, for the accumulation of which thousands of years were required.

MOON HELP

At Foo-Chow, China, there is a stone bridge, more than a mile long, uniting the two parts of the city. It is not constructed with arches, but piers are built up from the bottom of the river and great granite stringers are laid horizontally from pier to pier. I measured some of these great stone stringers, and found them to be three feet square and forty-five feet long. They weigh over thirty tons each.

How could they be lifted, handled, and put in place over the water on slender piers? How was it done? There was no Hercules to perform the mighty labor, nor Amphion to lure them to their place with the music of his golden lyre.

Tradition says that the Chinese, being astute astronomers, got the moon to do the work. It was certainly very shrewd, if they did. Why not use the moon for more than a lantern? Is it not a part of the “all things” over which man was made to have dominion?

Well, the Chinese engineers brought the great granite blocks to the bridge site on floats, and when the tide lifted the floats and stones they blocked up the stones on the piers and let the floats sink with the outgoing tide. Then they blocked up the stones on the floats again, and as the moon lifted the tides once more they lifted the stones farther toward their place, until at length the work was done for each set of stones.

Dear, good moon, what a pull you have! You are not merely for the delight of lovers, pleasant as you are for that, but you are ready to do gigantic work.

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No wonder that the Chinese, as they look at the solid and enduring character of that bridge, name it, after the poetic and flowery habit of the country, “The Bridge of Ten Thousand Ages.”

MORE MOON HELP

Years ago, before there were any railroads, New York city had thousands of tons of merchandise it wished to send out West. Teams were few and slow, so they asked the moon to help. It was ready; had been waiting thousands of years.

We shall soon see that it is easy to slide millions of tons of coal down hill, but how could we slide freight up from New York to Albany?

It is very simple. Lift up the lower end of the river till it shall be down hill all the way to Albany. But who can lift up the end of the river? The moon. It reaches abroad over the ocean and gathers up water from afar, brings it up by Cape Hatteras and in from toward England, pours it in through the Narrows, fills up the great harbor, and sets the great Hudson flowing up toward Albany. Then men put their big boats on the current and slide up the river. Six hours later the moon takes the water out of the harbor and lets other boats slide the other way.

New York itself has made use of the moon to get rid of its immense amount of garbage and sewage. It would soon breed a pestilence, and the city be like the buried cities of old; but the moon comes to its aid, and carries away and buries all this foul breeder of a pestilence, and washes all the harbor and bay with clean floods of water twice a day. Good moon! It not only lights, but works.

The tide in New York Harbor rises only about five feet; up in the Bay of Fundy it ramps, rushes, raves, and rises more than fifty feet high.

In former times men used to put mill wheels into the currents of the tides; when they rushed into little bays and salt ponds they turned the wheels one way; when out, the other.

STAR HELP

“We for whose sake all Nature stands,
And stars their courses move.”

Do the stars, that are so far away and seem so small, send us any help? Assuredly. Nothing exists for itself. All is for man.

Magnetism tells the sailor which way he is going. Stars not only do this, when visible, but they also tell just where on the round globe he is. A glance into their bright eyes, from a rolling deck, by an uneducated sailor, aided by the tables of accomplished scholars, tells him exactly where he is—in mid Atlantic, Pacific, Indian, Arctic, or Antarctic Ocean, or at the mouth of the harbor he has sought for months. We lift up our eyes higher than the hills. Help comes from the skies.

This help was started long since, with providential foresight and care. Is he steering by the North Star? A ray of guidance was sent from that lighthouse in the sky half a century before his need, that it might arrive just at the critical time. It has been ever since on its way.

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The stars give us, on land and sea, all our reliable standards of time. There is no other source. They are reliable to the hundredth part of a second.

The Italian physicians, in their ignorance of the origin of a disease, named it the influenza, because they imagined that it came from the influence of the stars. No! There is nothing malign in the sweet influences of the Pleiades.

The stars are of special use as a mental gymnasium. On their lofty bars and trapezes the mind can swing itself higher and farther than on any other material thing. Infinity and omnipotence are factors in their problems. They also fill the soul of the rapt beholder with adoring wonder. They are the greatest symbols of the unweariableness of the power and of the minuteness of the knowledge of God. He calleth all their millions by name, and for the greatness of his power not one faileth to come.

Number the stars of a clear Eastern sky, if you are able. So multitudinous and enduring shall the influence of one good man be.

HELP FROM INSENSIBLE SEAS

Suppose one has been at sea a month. He has tacked to every point of the compass, been driven by gales, becalmed in doldrums. At length Euroclydon leaps on him, and he lets her drive. And when for many days and nights neither sun nor stars appear, how can he tell where he is, which way he drives, where the land lies?

There is an insensible ocean. No sense detects its presence. It has gulf streams that flow through us, storms whose waves engulf us, but we feel them not. There are various intensities of its power, the north end of the world not having half as much as the south. There are two places in the north half of the world that have greater intensity than the rest, and only one in the south. It looks as if there were unsoundable depths in some places and shoals in others.

The currents do not flow in exactly the same direction all the time, but their variations are within definite limits.

How shall we detect these steady currents when wind and waves are in tumultuous confusion? They are always present. No winds blow them aside, no waves drench their subtle fire, no mountains make them swerve. But how shall we find them?

Float a bit of magnetic ore in a pail of water, or suspend a bit of magnetized steel by a thread, and these currents make the ore or needle point north and south. Now let waves buffet either side, typhoons roar, and maelstroms whirl; we have, out of the invisible, insensible sea of magnetic influence, a sure and steady guide. Now we can sail out of sight of headlands. We have in the darkness and light, in calm and storm, an unswerving guide. Now Columbus can steer for any new world.

Does not this seem like a spiritual force? Lodestone can impart its qualities to hard steel without the impairment of its own power. There is a giving that does not impoverish, and a withholding that does not enrich.

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Wherever there is need there is supply. The proper search with appropriate faculties will find it. There are yet more things in heaven and earth than are dreamed of in our philosophy.

THE FAIRY GRAVITATION

The Germans imagine that they have fairy kobolds, sprites, and gnomes which play under ground and haunt mines. I know a real one. I will give you his name. It is called "Gravitation." The name does not sound any more fairylike than a sledge hammer, but its nature and work are as fairylike as a spider's web. I will give samples of his helpful work for man.

In the mountains about Saltzburg, south of Munich, are great thick beds of solid salt. How can they get it down to the cities where it is needed? Instead of digging it out, and packing it on the backs of mules for forty miles, they turn in a stream of water and make a little lake which absorbs very much salt—all it can carry. Then they lay a pipe, like a fairy railroad, and gravitation carries the salt water gently and swiftly forty miles, to where the railroads can take it everywhere. It goes so easily! There is no railroad to build, no car to haul back, only to stand still and see gravitation do the work.

How do they get the salt and water apart? O, just as easily. They ask the wind to help them. They cut brush about four feet long, and pile it up twenty feet high and as long as they please. Then a pipe with holes in it is laid along the top, the water trickles down all over the loose brush, and the thirsty wind blows through and drinks out most of the water. They might let on the water so slowly that all of it would be drunk out by the wind, leaving the solid salt on the bushes. But they do not want it there. So they turn on so much water that the thirsty wind can drink only the most of it, and the rest drops down into great pans, needing only a little evaporation by boiling to become beautiful salt again, white as the snows of December.

There are other minerals besides salt in the beds in the mountains, and, being soluble in water, they also come down the tiny railroad with musical laughter. How can we separate them, so that the salt shall be pure for our tables?

The other minerals are less avaricious of water than salt, so they are precipitated, or become solid, sooner than salt does. Hence with nice care the other minerals can be left solid on the bushes, while the salt brine falls off. Afterward pure water can be turned on and these other minerals can be washed off in a solution of their own. No fairies could work better than those of solution and crystallization.

MORE GRAVITATION

At Hutchinson, Kan., there are great beds of solid rock salt four hundred feet below the surface. Men want to get and use two thousand barrels a day. How shall they get it to the top of the ground? They might dig a great well—or, as the miners say, sink a shaft—pump out the water, go down and blast out the salt, and laboriously haul it up in defiance of gravitation. No; that is too hard. Better ask this strong gravitation to bring it up.

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But does it work down and up? Did any one ever know of gravitation raising anything? O yes, many things. A balloon may weigh as much as a ton, but when inflated it weighs less than so much air; so the heavier air flows down under and shoulders it up. When a heavy weight and a light one are hung over a pulley, the light one goes up because gravity acts more on the other. Water poured down a long tube will rise if the tube is bent up into a shorter arm.

Exactly. So we bore a four-inch hole down to the salt and put in an iron tube.

We do not care about the water. It is no bother. Then inside of this tube we put a two-inch tube that is a few feet higher. Now pour water down the small longer tube. It saturates itself with salt, and comes flowing over the top of the shorter tube as easily as water runs down hill. Multiply the wells, dry out the water, and you have your two thousand barrels of salt lifted every day—just as easy as thinking!

We want a steady, unswerving force that will pull our clock hands with an exact motion day and night, year in and year out. We hang up a string, and ask gravitation to take hold and pull. We put on some lead or brass for a handle, to take hold of. It takes hold and pulls, unweariedly, unvaryingly, and ceaselessly.

It turns single water-wheels with a power of more than twelve hundred horses.

It holds down houses, so that they are not blown away. It was made to serve man, and it works without a grumble.

Thus the higher force in nature always prevails over the lower, and the greater amount over the less amount of the same force. What is the highest force?

THE FAIRY PULLS GREAT LOADS

Far back in the hills west of Mauch Chunk, Pa., lie great beds of coal. They were made under the sea long ages ago, raised up, roofed over by the Allegheny Mountains, and kept waiting as great reservoirs of power for the use of man.

But how can these mountains be gotten to the distant cities by the sea? Faith in what power can say to these mountains, “Be thou removed far hence, and cast into the sea?” It is easy.

Along the winding sides of the mountains have been laid two rails like steel ribbons for a dozen miles, from the coal beds to water and railroad transportation. Put a half dozen loaded cars on the track, and with one man at the brake, lest gravitation should prove too willing a helper, away they go, through the springtime freshness or the autumn glory, spinning and singing down to the point of universal distribution.

[Illustration: Incline at Mauch Chunk.]

On one occasion the brake for some reason would not work. The cars just flew like an arrow. The man's hair stood up from fright and the wind. Coming to a curve the cars kept straight on, ran down a bank, dashed right into the end of a house and spilled their whole load in the cellar. Probably no man ever laid in a winter's supply of coal so quickly or so undesirably.

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But how do we get the cars back? It is pleasant sliding down hill on a rail, but who pulls the sled back? Gravitation. It is just as willing to work both ways as one way.

Think of a great letter X a dozen miles long.

Lay it down on the side against three or four rough hills. Bend the X till it will fit the curves and precipices of these hills. That is the double track. Now when loaded cars have come down one bar of the X by gravity, draw them up by a sharp incline to the upper end of the other bar, and away they go by gravity to the other end. Draw them up one more incline, and they are ready to take a new load and buzz down to the bottom again.

I have been riding round the glorious mountain sides in a horseless, steamless, electricityless carriage, and been delighted to find hundreds of tons of coal shooting over my head at the crossings of the X, and both cars were drawn in opposite directions by the same force of gravity in the heart of the earth.

If you do not take off your hat and cheer for the superb force of gravitation, the wind is very apt to take it off for you.

THE FAIRY DRAWS GREATER LOADS

Pittsburg has 5,000,000 tons of coal every year that it wishes to send South, much of it as far as New Orleans—2,050 miles. What force is sufficient for moving such great mountains so far? Any boy may find it.

Tie a stone to the end of a string, whirl it around the finger and feel it pull. How much is the pull? That depends on the weight of the stone, the length of the string, and the swiftness of the whirl. In the case of David's sling it pulled away hard enough to crash into the head of Goliath. Suppose the stone to be as big as the earth (8,000 miles in diameter), the length of the string to be its distance from the sun (92,500,000 miles), and the swiftness of flight the speed of the earth in its orbit (1,000 miles a minute). The pull represents the power of gravitation that holds the earth to the sun.

If we use steel wires instead of gravitation for this purpose, each strong enough to support half a score of people (1,500 pounds), how many would it take? We would need to distribute them over the whole earth: from pole to pole, from side to side, over all the land and sea. Then they would need to be so near together that a mouse could not run around among them.

Here is a measureless power. Can it be gotten to take Pittsburgh coal to New Orleans? Certainly; it was made to serve man. So the coal is put on great flatboats, 36 x 176 feet, a thousand tons to a boat, and gravitation takes the mighty burden down the long toboggan slide of the Ohio and Mississippi Rivers to the journey's end. How easy!

[Illustration: The Head of the Toboggan Slide.]

One load sent down was 43,000 tons. The flatboats were lashed together as one solid boat covering six and one half acres, more space than a whole block of houses in a city, with one little steamboat to steer. There is always plenty of power; just belt on for anything you want done. This is only one thing that gravitation does for man on these rivers. And there are many rivers. They serve the savage on his log and the scientist in his palace steamer with equal readiness.

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THE FAIRY WORKS A PUMP HANDLE

The Slave of the Ring could take Aladdin into a cave of wealth, and by speaking the words, “Open Sesame,” Ali Baba was admitted into the cave that held the treasures of the forty thieves. But that is very little. I have just come from a cave in Virginia City, Nev., from which men took $120,000,000.

In following the veins of silver the miners went down 3,500 feet—more than three fifths of a mile. There it was fearfully hot, but the main trouble was water. They had dug a deep, deep well. How could they get the water out? Pumps were of no use. A column of water one foot square of that height weighs 218,242 pounds. Who could work the other end of the pump handle?

They thought of evaporating the water and sending it up as steam. But it was found that it would take an incredible amount of coal. They thought of separating it into oxygen and hydrogen, and then its own lightness would carry it up very quickly. But they had no power that would resolve even quarts into their ultimate elements, where tons would be required.

So they asked gravitation to help them. It readily offered to do so. It could not let go its hold of the water in the mine, nor anywhere else, for fear everything would go to pieces, but it offered to overcome force with greater force. So it sent the men twenty miles away in the mountains to dig a ditch all the way to the mine, and then gravitation brought water to a reservoir four hundred feet above the mouth of the mine. Now a column of this water one foot square can be taken from this higher reservoir down to the bottom of the mine and weigh 25,000 pounds more than a like column that comes from the bottom to the top. This extra 25,000 pounds is an extra force available to lift itself and the other water out of the deep well, and they turn the greater force into a pump and work it in the cylinder as if it were steam. It lifts not only the water that works the pump, but the other water also out of the mine by gravitation. So man gets the water out by pouring more water in.

THE HELP OF INERTIA

Since the time of David many boys have swung pebbles by a string, or sling, and felt the pull of what we call a centrifugal (center-fleeing) force. David utilized it to one good purpose. Goliath was greatly surprised; such a thing never entered his head before. Whether a stone or an idea enters one’s head depends on the kind of head he has.

We utilize this force in many ways now. Some boys swing a pail of milk over their heads, and if swung fast enough the centrifugal force overcomes the force of gravitation, and the milk does not fall. That is not utilizing the force. It often terrorizes the careful mother, anxious for the safety of the milk.

But in the arts of practical life we do utilize this force, which is only inertia.

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Once it took a long time for molasses to drain out of a hogshead of damp sugar. Now it is put into a great tub, with holes in the side, which is made to revolve rapidly, and the molasses flies out. In the best laundries clothes are not wrung out, to the great damage of tender fabrics, but are put into such a tub and whirled nearly dry. So fifty yards of woolen cloth just out of the dye vat—who could wring it? It is coiled in a tub called a wizard, and whirled.

Muddy water is put through a process called clarification. It is the same, except that there are no holes in the vessel. The heavier particles of dirt, that would settle in time, take the outside, leaving perfectly clean water in the middle. A perpendicular perforated pipe, with a faucet below, drains off all the clear water and leaves all the mud. Milk is brought in from the milking and put into a separator; whirl it, and the heavier milk takes the outside of the whirling mass, and the lighter cream can be drawn off from the middle. It is far more perfectly separated than by any skimming.

A rotary snowplow slices off two feet of a ten-foot drift at each revolution, and by centrifugal force flings it out of the cutting with a speed that a hundred navvies or dagos cannot equal.

ONE PLANT HELP

A thousand acres of land on Cape Cod were once blown away. This wind excavation was ten feet deep. It was not an extraordinary wind, but extraordinary land. It was made of rock ground up into fine sand by the waves on the shore.

In all the deserts of the world the wind blows the itinerant sand on its far journeys. If the wind is moderate it heaps the sand up into little hills, some of them six hundred feet high, around any obstruction, and then blows the sand up the slanting face of the hill and over the top, where it falls out of the wind on the leeward side. In this way the hill is always traveling. In North Carolina hills start inland, and travel right on, burying a house or farm if it be in the way, but resurrecting it again on the other side as the hill goes on. Anyone may see these hills at the south end of Lake Michigan, as he approaches Chicago, west of San Francisco, all along up the Columbia River—the sand having come on the wings of the wind from the coast.

But to see the whole visible world on a march one needs to go to a really large desert. The Pyramids and the Sphinx have been partly buried, and parts of the valley of the Nile threatened, by hordes of sand hills marching in from the desert; cities have been buried and harbors filled up. Many of the harbors of the ancient civilizations are mere miasmatic marshes now. This is partly in consequence of the silt brought in by the rivers; but where the rivers do not flow in it is because the sand blows in along the shore. Harbors are especially endangered when their protection from the waves

consists of a bank of sand, as on Cape Cod and the Sandy Hook below the Narrows of the harbor of New York.

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How can man combat part of the continent on the move, driven by the ceaseless powers of the air? By a humble plant or two. The movement of the sand hills that threaten to destroy the marvelous beauty of the grounds of the Hotel del Monte at Monterey is stopped by planting dwarf pines. The sand dunes that prevent much of Holland from being reconquered by the sea are protected with great care by willows, *etc*., and the coast sands of parts of eastern France have been sown with sea pine and broom.

The tract of a thousand acres on Cape Cod had been protected by humble beach grass. Some careless herder let the cows eat it in places, and away went part of a township. It is now a punishable crime on Cape Cod to destroy beach grass.

GAS HELP

This refers to more than stump speech-making. The old Romans drove through solid rock numerous tunnels similar to the one for draining Lago de Celano, fifty miles east of Rome. This one was three and a half miles long, through solid rock, and every chip cost a blow of a human arm to dislodge it. Of course the process was very slow.

We do works vastly greater. We drive tunnels three times as long for double-track railways through rock that is held down by an Alp. We use common air to drill the holes and a thin gas to break the rock. The Mont Cenis tunnel required the removal of 900,000 cubic yards of rock. Near Dover, England, 1,000,000,000 tons of cliff were torn down and scattered over fifteen acres in an instant. How was it done? By gas.

There are a dozen kinds of solids which can be handled—some of them frozen, thawed, soaked in water, with impunity—but let a spark of fire touch them and they break into vast volumes of uncontrollable gas that will rend the heart out of a mountain in order to expand.

Gunpowder was first used in 1350; so the old Romans knew nothing of its power. They flung javelins a few rods by the strength of the arm; we throw great iron shells, starting with an initial velocity of fifteen hundred feet a second and going ten miles. The air pressure against the front of a fifteen-inch shell going at that speed is 2,865 pounds. That ton and a half of resistance of gas in front must be much more than overcome by gas behind.

But the least use of explosives is in war; not over ten per cent is so used. The Mont Cenis tunnel took enough for 200,000,000 musket cartridges. As much as 2,000 kegs have been fired at once in California to loosen up gravel for mining, and 23 tons were exploded at once under Hell Gate, at New York.

How strong is this gas? As strong as you please. Steam is sometimes worked at a pressure of 400 pounds to the inch, but not usually over 100 pounds. It would be no use to turn steam into a hole drilled in rock. The ordinary pressure of exploded gas is 80,000 pounds to the square inch. It can be made many times more forceful. It works as well in water, under the sea, or makes earthquakes in oil wells 2,000 feet deep, as under mountains.

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The wildest imagination of Scheherezade never dreamed in *Arabian Nights* of genii that had a tithe of the power of these real forces. Her genii shut up in bottles had to wait centuries for some fisherman to let them out.

NATURAL AFFECTION OF METALS

“Sacra fames auri.” The hunger for gold, which in men is called accursed, in metals is justly called sacred.

In all the water of the sea there is gold—about 400 tons in a cubic mile—in very much of the soil, some in all Philadelphia clay, in the Pactolian sands of every river where Midas has bathed, and in many rocks of the earth. But it is so fine and so mixed with other substances that in many cases it cannot be seen. Look at the ore from a mine that is giving its owners millions of dollars. Not a speck of gold can be seen. How can it be secured? Set a trap for it. Put down something that has an affinity—voracious appetite, unslakable thirst, metallic affection—for gold, and they will come together.

We have heard of potable gold—“*potabile aurum*.” There are metals to which all gold is drinkable. Mercury is one of them. Cut transverse channels, or nail little cleats across a wooden chute for carrying water. Put mercury in the grooves or before the cleats, and shovel auriferous gravel and sand into the rushing water. The mercury will bibulously drink into itself all the fine invisible gold, while the unaffectionate sand goes on, bereaved of its wealth.

Put gold-bearing quartz under an upright log shod with iron. Lift and drop the log a few hundred times on the rock, until it is crushed so fine that it flows over the edge of the trough with constantly going water, and an amalgam of mercury spread over the inclined way down which the endusted water flows will drink up all the gold by force of natural affection therefor.

Neither can the gold be seen in the mercury. But it is there. Squeeze the mercury through chamois skin. An amalgam, mostly gold, refuses to go through. Or apply heat. The mercury flies away as vapor and the gold remains.

If thou seekest for wisdom as for silver, and searchest for her as for hid treasure, thou shalt find.

NATURAL AFFECTION BETWEEN METAL AND LIQUID

A little boy had a silver mug that he prized very highly, as it was the gift of his grandfather. The boy was not born with a silver spoon in his mouth, but, what was much better, he had a mug often filled with what he needed.

One day he dipped it into a glass jar of what seemed to him water, and letting go of it saw it go to the bottom. He went to find his father to fish it out for him. When he came back his heavy solid mug looked as if it were made of the skeleton leaves of the forest when the green chlorophyll has decayed away in the winter and left only the gauzy veins and veinlets through which the leaves were made. Soon even this fretwork was gone, and there was no sign of it to be seen. The liquid had eaten or drank the solid metal up, particle by particle. The liquid was nitric acid.

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The poor little boy had often seen salt, and especially sugar, absorbed in water, but never his precious solid silver mug, and the bright tears rolled down his cheeks freely.

But his father thought of two things: First, that the blue tint told him that the jeweler had sold for silver to the grandfather a mug that was part copper; and secondly, that he would put some common salt into the nitric acid—which it liked so much better than silver that it dropped the silver, just as a boy might drop bread when he sought to fill his hands with cake.

So the father recovered the invisible silver and made it into a precious mug again.

NATURAL AFFECTION OP METAL AND GAS

A man was waked up one night in a strange house by a noise he could not understand. He wanted a light, and wanted it very much, but he had no matches that would take fire by the heat of friction. He knew of many other ways of starting a fire. If water gets to the cargo of lime in a vessel it sets the ship on fire. It is of no use to try to put it out by water, for it only makes more heat. He knew that dried alum and sugar suitably mixed would burst into flame if exposed to the air; that nitric acid and oil of turpentine would take fire if mixed; that flint struck by steel would start fire enough to explode a powder magazine; and that Elijah called down from heaven a kind of fire that burned twelve “barrels” of water as easily as ordinary water puts out ordinary fire. But he had none of these ways of lighting his candle at hand—not even the last.

So he took a bit of potassium metal, bright as silver, out of a bottle of naphtha, put it in the candle wick, touched it with a bit of dripping ice, and so lighted his candle.

The potassium was so avaricious of oxygen that it decomposed the water to get it. Indeed, it was a case of mutual affection. The oxygen preferred the company of potassium to that of the hydrogen in the water, and went to it even at the risk of being burned.

I was so interested in seeing a bit of silver-like metal and water take fire as they touched that I forgot all about the occasion of the noise.

HINT HELP

Benjamin C. B. Tilghman, of Philadelphia, once went into the lighthouse at Cape May, and, observing that the window glass was translucent rather than transparent, asked the keeper why he put ground glass in the windows. “We do not,” said the keeper. “We put in the clear glass, and the wind blows the sand against it and roughens the outer surface like ground glass.” The answer was to him like the falling apple to Newton. He put on his thinking cap and went out. It was better than the cap of Fortunatus to him.

He thought, “If nature does this, why cannot I make a fiercer blast, let sand trickle into it, and so hurl a million little hammers at the glass, and grind it more swiftly than we do on stones with a stream of wet sand added?”

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He tried jets of steam and of air with sand, and found that he could roughen a pane of glass almost instantly. By coating a part of the glass with hot beeswax, applied with a brush, through a stencil, or covering it with paper cut into any desired figures, he could engrave the most delicate and intricate patterns as readily as if plain. Glass is often made all white, except a very thin coating of brilliant colored glass on one side. This he could cut through, leaving letters of brilliant color and the general surface white, or *vice versa*.

Seal cutting is a very delicate and difficult art, old as the Pharaohs. Protect the surface that is to be left, and the sand blast will cut out the required design neatly and swiftly.

There is no known substance, not even corundum, hard enough to resist the swift impact of myriads of little stones.

It will cut more granite into shape in an hour than a man can in a day.

Surely no one will be sorry to learn that General Tilghman sold part of his patents, taken out in October, 1870, for $400,000, and receives the untold benefits of the rest to this day. So much for thinking.

Nature gives thousands of hints. Some can take them; some can only take the other thing. The hints are greatly preferred by nature and man.

CREATIONS NOW IN PROGRESS

The forces of creation are yet in full play. Who can direct them? Rewards greater than Tilghman's await the thinker. We are permitted not only to think God's thoughts after him, but to do his works. "Greater works than these that I do shall he do who believeth on me," says the Greatest Worker. Great profit incites to do the work noted below.

Carbon as charcoal is worth about six cents a bushel; as plumbago, for lead pencils or for the bicycle chain, it is worth more; as diamond it has been sold for $500,000 for less than an ounce, and that was regarded as less than half its value. Such a stone is so valuable that $15,000 has been spent in grinding and polishing its surface. The glazier pays $5.00 for a bit of carbon so small that it would take about ten thousand of them to make an ounce.

Why is there such a difference in value? Simply arrangement and compactness. Can we so enormously enhance the value of a bushel of charcoal by arrangement and compression? Not very satisfactorily as yet. We can apply almost limitless pressure, but that does not make diamonds. Every particle must go to its place by some law and force we have not yet attained the mastery of.

We do not know and control the law and force in nature that would enable us to say to a few million bricks, stones, bits of glass, *etc*., “Fly up through earth, water, and air, and combine into a perfect palace, with walls, buttresses, towers, and windows all in exact architectural harmony.” But there is such a law and force for crystals, if not for palaces. There is wisdom to originate and power to manage such a force. It does not take masses of rock and stick them together, nor even particles from a fluid, but atoms from a gas. Atoms as fine as those of air must be taken and put in their place, one by one, under enormous pressure, to have the resulting crystal as compact as a diamond.

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The force of crystallization is used by us in many inferior ways, as in making crystals of rock candy, sulphur, salt, *etc*., but for the making of diamonds it is too much for us, except in a small way.

While we cannot yet use the force that builds large white diamonds we can use the diamonds themselves. Set a number of them around a section of an iron tube, place it against a rock, at the surface or deep down in a mine, cause it to revolve rapidly by machinery, and it will bore into the rock, leaving a core. Force in water, to remove the dust and chips, and the diamond teeth will eat their way hundreds of feet in any direction; and by examining the extracted core miners can tell what sort of ore there is hundreds of feet in advance. Hence, they go only where they know that value lies.

SOME CURIOUS BEHAVIORS OF ATOMS

Ultimate atoms of matter are asserted to be impenetrable. That is, if a mass of them really touched each other, that mass would not be condensible by any force. But atoms of matter do not touch. It is thinkable, but not demonstrable, that condensation might go on till there were no discernible substance left, only force.

Matter exists in three states: solid, liquid, and gas. It is thought that all matter may be passed through the three stages—iron being capable of being volatilized, and gases condensed to liquids and solids—the chief difference of these states being greater or less distance between the constituent atoms and molecules. In gas the particles are distant from each other, like gnats flying in the air; in liquids, distant as men passing in a busy street; in solids, as men in a congregation, so sparse that each can easily move about. The congregation can easily disperse to the rarity of those walking in the street, and the men in the street condense to the density of the congregation. So, matter can change in going from solids to liquids and gases, or *vice versa*. The behavior of atoms in the process is surpassingly interesting.

Gold changes its density, and therefore its thickness, between the two dies of the mint that make it money. How do the particles behave as they snuggle up closer to each other?

Take a piece of iron wire and bend it. The atoms on the inner side become nearer together, those on the outside farther apart. Twist it. The outer particles revolve on each other; those of the middle do not move. They assume and maintain their new relations.

Hang a weight on a wire. It does not stretch like a rubber thread, but it stretches. Eight wires were tested as to their tensile strength. They gave an average of forty-five pounds, and an elongation averaging nineteen per cent of the total length. Then a wire of the same kind was given time to adjust itself to its new and trying circumstances.

Forty pounds were hung on one day, three pounds more the next day, and so on, increasing the weights by diminishing quantities, till in sixty days it carried fifty-seven pounds. So it seems that exercise strengthened the wire nearly twenty-seven per cent.

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While those atoms are hustling about, lengthening the wire and getting a better grip on one another, they grow warm with the exercise. Hold a thick rubber band against your lip—suddenly stretch it. The lip easily perceives the greater heat. After a few moments let it contract. The greater coldness is equally perceptible.

A wire suspending thirty-nine pounds being twisted ninety-five full turns lengthened itself one sixteen-hundredth of its length. Being further twisted by twenty-five turns it shortened itself one fourth of its previous elongation. During the twisting some sections took far more torsion than others. A steel wire supporting thirty-nine pounds was twisted one hundred and twenty times and then allowed to untwist at will. It let out only thirty-eight turns and retained eighty-two in the new permanent relation of particles. A wire has been known to accommodate itself to nearly fourteen hundred twists, and still the atoms did not let go of each other. They slid about on each other as freely as the atoms of water, but they still held on. It is easier to conceive of these atoms sliding about, making the wire thinner and longer, when we consider that it is the opinion of our best physicists that molecules made of atoms are never still. Masses of matter may be still, but not the constituent elements. They are always in intensest activity, like a mass of bees—those inside coming out, outside ones going in—but the mass remains the same.

The atoms of water behave extraordinarily. I know of a boiler and pipes for heating a house. When the fire was applied and the temperature was changed from that of the street to two hundred degrees, it was easy to see that there was a whole barrel more of it than when it was let into the boiler. It had been swollen by the heat, but it was nothing but water.

Mobile, flexible, and yielding as water seems to be, it has an obstinacy quite remarkable. It was for a long time supposed to be absolutely incompressible. It is nearly so. A pressure that would reduce air to one hundredth of its bulk would not discernibly affect water. Put a ton weight on a cubic inch of water; it does not flinch nor perceptibly shrink, yet the atoms of water do not fill the space they occupy. They object to being crowded. They make no objection to having other matter come in and possess the space unoccupied by them.

Air so much enjoys its free, agile state, leaping over hills and plains, kissing a thousand flowers, that it greatly objects to being condensed to a liquid. First we must take away all the heat. Two hundred and ten degrees of heat changes water to steam filling 1,728 times as much space. No amount of pressure will condense steam to water unless the heat is removed. So take heat away from air till it is more than two hundred degrees below zero, and then a pressure of about two hundred atmospheres (14.7 pounds each) changes common air to fluid. It fights desperately against condensation, growing hot with the effort, and it maintains its resilience for years at any point of pressure short of the final surrender that gives up to become liquid.

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Perhaps sometime we shall have the pure air of the mountains or the sea condensed to fluid and sold by the quart to the dwellers in the city, to be expanded into air once more.

The marvel is not greater that gas is able to sustain itself under the awful pressure with its particles in extreme dispersion, than that what we call solids should have their molecules in a mazy dance and yet keep their strength.

Since this world, in power, fineness, finish, beauty, and adaptations, not only surpasses our accomplishment, but also is past our finding out to its perfection, it must have been made by One stronger, finer, and wiser than we are.

MOBILITY OF SEEMING SOLIDS

When a human breath, or the white jet of a steam whistle, or the black cough of a locomotive smokestack is projected into the air it is easy to see that the air is mobile. Its particles easily roll over one another in voluminously infolding wreaths. The same is seen in water. The crest of a wave falls over a portion of air, imprisoning it for a moment, and the mingled air and water of different densities prevent the light of the sun or sky from going straight down into the black depths and being lost, but by being reflected and turned back it shows like beautiful white lace, constantly created and dissolved with a thousandfold more beauty than any that ever came from human hands. All the three shifting elements of the swift creations are mobile. This seems to be the case because these elements are not solid. The particles have plenty of room to play about each other, to execute mazy dances and minuets with vastly more space than substance.

Extend the thought a little. Things that seem to us most solid are equally mobile. An iron wire seems solid. It is so; some parts much more so than others. The surface that has been in closest contact with the die as the wire was drawn through, reducing its size by one half, perhaps, is vastly more dense than the inner parts that have not been so condensed. File away one tenth of a wire, taking it all from the surface, and you weaken the tensile strength of the wire one half.

But, dense and solid as this iron is, its particles are as mobile within certain limits as the particles of air. An electric message sent through a mile of wire is not anything transmitted; matter is not transferred, but the particles are set to dancing in wavy motion from end to end. Particles are leaping within ordered limits and according to regular laws as really as the clouds swirl and the air trembles into song through the throat of a singer. When a wire is made sensitive by electricity the breath of a child can make it vibrate from end to end, ensouled with the child’s laughter or fancies. Nay, more, and far more wonderful, the wire will be sensitive to the number of vibrations of a certain note of music, and no receiver at the other end will gather up its

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sensitive tremblings unless it is pitched to the keynote of the vibrations sent. In this way eight sets of vibrations have been sent on one wire both ways at the same time, and no set of signals has in any way interfered with the completeness and audibility of the rest. Sixteen sets of waltzes were being performed at one and the same time by the particles of one wire without confusion. Because the air is transmitting the notes of an organ from the loft to the opposite end of the church, it is not incapable of bringing the sound of a voice in an opposite direction to the organist from the other end of the church.

The extreme mobility of steel is seen when the red-hot metal is plunged into water. Instantly every particle takes a new position, making it a hundredfold more hard than before it was heated. But these particles of transferred steel are still mobile. A man's razor does not cut smoothly. It is dull, or has a ragged edge that is more inclined to draw tears than cut hairs. He draws the razor over the tender palm of his hand a few times, rearranges the particles of the edge and builds them out into a sharper form. Then the razor returns to the lip with the dainty touch of a kiss instead of a saw. Or the tearful man dips the razor in hot water and the particles run out to make a wider blade and, of course, a thinner, sharper edge. Drop the tire of a wagon wheel into a circular fire. As the heat increases each particle says to its neighbor, "Please stand a little further off; this more than July heat is uncomfortable." So the close friends stand a little further apart, lengthening the tire an inch or two. Then, being taken out of the fire and put on the wheel and cooled, the particles snuggle up together again, holding the wheel with a grip of cold iron. Mobile and loose, with plenty of room to play, as the particles have, neither wire nor tire loses its tensile strength. They hold together, whether arms are locked around each other's waist, or hand clasps hand in farther reach. What change has come to iron when it has been made red or white hot? Its particles have simply been mobilized. It differs from cold iron as an army in barracks and forts differs from an army mobilized. Nothing has been added but movement. There is no caloric substance. Heat is a mode of motion. The particles of iron have been made to vibrate among themselves. When the rapidity of movement reaches four hundred and sixty millions of millions of vibrations per second it so affects the eye that we say it is red-hot. When other systems of vibration have been added for yellow, *etc*., up to seven hundred and thirty millions of millions for the violet, and all continue in full play, the eye perceives what we call white heat. It is a simple illustration of the readiness of seeming solids to vibrate with almost infinite swiftness.

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I have been to-day in what is to me a kind of heaven below—the workshop of my much-loved friend, John A. Brashear, in Allegheny, Pa. He easily makes and measures things to one four-hundred-thousandth of an inch of accuracy. I put my hand for a few seconds on a great piece of glass three inches thick. The human heat raised a lump detectable by his measurements. We were testing a piece of glass half an inch thick; and five inches in diameter. I put my two thumbnails at the two sides as it rested on its bed, and could see at once that I had compressed the glass to a shorter diameter. We twisted it in so many ways that I said, "That is a piece of glass putty." And yet it was the firmest texture possible to secure. Great lenses are so sensitive that one cannot go near them without throwing them discernibly out of shape. It were easy to show that there is no solid earth nor immovable mountains. I came away saying to my friend, "I am glad God lets you into so much of his finest thinking." He is a mechanic, not a theologian. This foremost man in the world in his fine department was lately but a "greasy mechanic," an engineer in a rolling mill.

But for elasticity and mobility nothing approaches the celestial ether. Its vibrations reach into millions of millions per second, and its wave-lengths for extreme red light are only .0000266 of an inch long, and for extreme violet still less—.0000167 of an inch.

It is easier molding hot iron than cold, mobile things than immobile. This world has been made elastic, ready to take new forms. New creations are easy, for man, even—much more so for God. Of angels, Milton says:

"Thousands at his bidding speed,
And post o'er land and ocean without rest."

No less is it true of atoms. In him all things live and move. Such intense activities could not be without an infinite God immanent in matter.

THE NEXT WORLD TO CONQUER

Man's next realm of conquest is the celestial ether. It has higher powers, greater intensities, and quicker activities than any realm he has yet attempted.

When the emissory or corpuscular theory of light had to be abandoned a medium for light's interplay between worlds had to be conceived. The existence of an all-pervasive medium called the luminiferous ether was launched as a theory. Its reality has been so far demonstrated that but very few doubters remain.

What facts of its conditions and powers can be known? It differs almost totally from our conceptions of matter. Of the eighteen necessary properties of matter perhaps only one, extension, can be predicated of it. It is unlimited, all-pervasive; even where worlds are non-attractive, does not accumulate about suns or other bodies; has no structure,

chemical relations, nor inertia; is not heatable, and is not cognizable by any of our present senses. Does it not take us one step toward an apprehension of the revealed condition of spirit?

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Recall its actual activities. Two hundred and fifty-eight vibrations of air per second produce on the ear the sensation we call *do*, or *C* of the soprano scale; five hundred and sixteen give the upper *C*, or an octave above. So the sound runs up in air till, above, say, thirty-five thousand vibrations per second, there is plenty of sound inaudible to our ears. But not inaudible to finer ears. To them the morning stars sing together in mighty chorus:

"Forever singing as they shine,
'The hand that made us is divine.'"

Electricity has as great a variety of vibrations as sound. Since some kinds of electricity do not readily pass through space devoid of air, though light and heat do, it seems likely that some of the lower intensities and slower vibrations of electricity are not in ether but in air. Certainly some of the higher intensities are in ether. Between two hundred and four hundred millions of millions of vibrations of ether per second are the different sorts of heat. Between four hundred and eight hundred vibrations are the different colors of light. Beyond eight hundred vibrations there is plenty of light, invisible to our eyes, known as chemical rays and probably the Roentgen rays. Beyond these are there vibrations for thought-transference? Who knoweth?

These familiar facts are called up to show the almost infinite capacities and intensities of the ether. Matter is more forceful, as it is less dense. Rock is solid, and has little force except obstinate resistance. Steam is rarer and more forceful. Gases suddenly born of dynamite touched by fire in the rock under a mountain have the tremendous pressure of eighty thousand pounds to the square inch. Ether is so rare that its density, compared with water, is represented by a decimal fraction with twenty-seven ciphers before it.

When the worlds navigate this sea, do they plow through it as a ship through the waves, forcing them aside, or as a sieve letting the water through it? Doubtless the sieve is the better symbol. Certainly the vibrations flow through solid glass and most solid diamond. To be sure, they are a little hampered by the solid substance. The speed of light is reduced from one hundred and eighty thousand miles a second in space to one hundred and twenty thousand in glass. If ether can so readily go through such solids, no wonder that a spirit body could appear to the disciples, "the doors being shut."

Marvelous discoveries in the capacities of ether have been made lately. In 1842 Joseph Henry found that electric waves in the top of his house provoked action in a wire circuit in the cellar, through two floors and ceilings, without wire connections. More than twenty years ago Professor Loomis, of the United States coast survey, telegraphed twenty miles between mountains by electric impulses sent from kites. Last year Mr. Preece, the cable being broken, sent,

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without wires, one hundred and fifty-six messages between the mainland and the island of Mull, a distance of four and a half miles. Marconi, an Italian, has sent recognizable signals through seven or eight thick walls of the London post-office, and three fourths of a mile through a hill. Jagadis Chunder Bose, of India, has fired a pistol by an electric vibration seventy-five feet away and through more than four feet of masonry. Since brick does not elastically vibrate to such infinitesimal impulses as electric waves, ether must. It has already been proven that one can telegraph to a flying train from the overhead wires. Ether is a far better medium of transmission than iron. A wire will now carry eight messages each way, at the same time, without interference. What will not the more facile ether do?

Such are some of the first vague suggestions of a realm of power and knowledge not yet explored. They are mere auroral hints of a new dawn. The full day is yet to shine.

Like timid children, we have peered into the schoolhouse—afraid of the unknown master. If we will but enter we shall find that the Master is our Father, and that he has fitted up this house, out of his own infinite wisdom, skill, and love, that we may be like him in wisdom and power as well as in love.

OUR ENJOYMENT OF NATURE'S FORCES

We are a fighting race; not because we enjoy fights, but we enjoy the exercise of force. In early times when we knew of no forces to handle but our own, and no object to exercise them on but our fellow-men, there were feuds, tyrannies, wars, and general desolation. In the Thirty Years' War the population of Germany was starved and murdered down from sixteen millions to less than five millions.

But since we have found field, room, and ample verge for the play of our forces in material realms, and have acquired mastery of the superb forces of nature, we have come to an era of peace. We can now use our forces and those of nature with as real a sense of dominion and mastery on material things, resulting in comfort, as formerly on our fellow-men, resulting in ruin. We now devote to the conquest of nature what we once devoted to the conquest of men. There is a fascination in looking on force and its results. Some men never stand in the presence of an engine in full play without a feeling of reverence, as if they stood in the presence of God—and they do.

The turning to these forces is a characteristic of our age that makes it an age of adventure and discovery. The heart of equatorial Africa has been explored, and soon the poles will hold no undiscovered secrets.

Among the great monuments of power the mountains stand supreme. All the cohesions, chemical affinities, affections of metals, liquids, and gases are in full play, and the measureless power of gravitation. And yet higher forces have chasmed, veined, infiltrated, disintegrated, molded, bent the rocky strata like sheets of paper, and lifted the whole mass miles in air as if it were a mere bubble of gas.

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The study of these powers is one of the fascinations of our time. Let me ask you to enjoy with me several of the greatest manifestations of force on this world of ours.

THE MONTE ROSA

Many of us in America know little of one of the great subjects of thought and endeavor in Europe. We are occasionally surprised by hearing that such a man fell into a crevasse, or that four men were killed on the Matterhorn, or five on the Lyskamm, and others elsewhere, and we wonder why they went there. The Alps are a great object of interest to all Europe. I have now before me a catalogue of 1,478 works on the Alps for sale by one bookseller. It seems incredible. In this list are over a dozen volumes describing different ascents of a single mountain, and that not the most difficult. There are publications of learned societies on geology, entomology, paleontology, botany, and one volume of *Philosophical and Religious Walks about Mont Blanc*. The geology of the Alps is a most perplexing problem. The summit of the Jungfrau, for example, consists of gneiss granite, but two masses of Jura limestone have been thrust into it, and their ends folded over.

It is the habit, of the Germans especially, to send students into the Alps with a case for flowers, a net for butterflies, and a box for bugs. Every rod is a schoolhouse. They speak of the “snow mountains” with ardent affection. Every Englishman, having no mountains at home, speaks and feels as if he owned the Alps. He, however, cares less for their flowers, bugs, and butterflies than for their qualities as a gymnasium and a measure of his physical ability. The name of every mountain or pass he has climbed is duly burnt into his Alpenstock, and the said stock, well burnt over, is his pride in travel and a grand testimonial of his ability at home.

There are numerous Alpine clubs in England, France, and Italy. In the grand exhibition of the nation at Milan the Alpine clubs have one of the most interesting exhibits. This general interest in the Alps is a testimony to man’s admiration of the grandest work of God within reach, and to his continued devotion to physical hardihood in the midst of the enervating influences of civilization. There is one place in the world devoted by divine decree to pure air. You are obliged to use it. Toiling up these steeps the breathing quickens fourfold, till every particle of the blood has been bathed again and again in the perfect air. Tyndall records that he once staggered out of the murks and disease of London, fearing that his lifework was done. He crawled out of the hotel on the Bell Alp and, feeling new life, breasted the mountain, hour after hour, till every acrid humor had oozed away, and every part of his body had become so renewed that he was well from that time. In such a sanitarium, school of every department of knowledge, training-place for hardihood, and monument of Nature’s grandest work, man does well to be interested.

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You want to ascend these mountains? Come to Zermatt. With a wand ten miles long you can touch twenty snow-peaks. Europe has but one higher. Twenty glaciers cling to the mountain sides and send their torrents into the little green valley. Try yourself on Monte Rosa, more difficult to ascend than Mont Blanc; try the Matterhorn, vastly more difficult than either or both. A plumbline dropped from the summit of Monte Rosa through the mountain would be seven miles from Zermatt. You first have your feet shod with a preparation of nearly one hundred double-pointed hobnails driven into the heels and soles. In the afternoon you go up three thousand one hundred and sixteen feet to the Riffelhouse. It is equal to going up three hundred flights of stairs of ten feet each; that is, you go up three hundred stories of your house—only there are no stairs, and the path is on the outside of the house. This takes three hours—an hour to each hundred stories; after the custom of the hotels of this country, you find that you have reached the first floor. The next day you go up and down the Goerner Grat, equal to one hundred and seventy more stories, for practice and a view unequaled in Europe. Ordering the guide to be ready and the porter to call you at one o'clock, you lie down to dream of the glorious revelations of the morrow.

The porter's rap came unexpectedly soon, and in response to the question, "What is the weather?" he said, "Not utterly bad." There is plenty of starlight; there had been through the night plenty of live thunder leaping among the rattling crags, some of it very interestingly near. We rose; there were three parties ready to make the ascent. The lightning still glimmered behind the Matterhorn and the Weisshorn, and the sound of the tumbling cataracts was ominously distinct. Was the storm over? The guides would give no opinion. It was their interest to go, it was ours to go only in good weather. By three o'clock I noticed that the pointer on the aneroid barometer, that instrument that has a kind of spiritual fineness of feeling, had moved a tenth of an inch upward. I gave the order to start. The other parties said, "Good for your pluck! *Bon voyage, gute reise*," and went to bed. In an hour we had ascended one thousand feet and down again to the glacier. The sky was brilliant. Hopes were high. The glacier with its vast medial moraines, shoving along rocks from twenty to fifty feet long, was crossed in the dawn. The sun rose clear, touching the snow-peaks with glory, and we shouted victory. But in a moment the sun was clouded, and so were we. Soon it came out again, and continued clear. But the guide said, "Only the good God knows if we shall have clear weather." Men get pious amid perils. I thought of the aneroid, and felt that the good God had confided his knowledge to one of his servants.

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Leaving the glacier, we came to the real mountain. Six hours and a half will put one on the top, but he ought to take eight. I have no fondness for men who come to the Alps to see how quickly they can do the ascents. They simply proclaim that their object is not to see and enjoy, but to boast. We go up the lateral moraine, a huge ridge fifty feet high, with rocks in it ten feet square turned by the mighty plow of ice below. We scramble up the rocks of the mountain. Hour after hour we toil upward. At length we come to the snow-slopes, and are all four roped together. There are great crevasses, fifty or a hundred feet deep, with slight bridges of snow over them. If a man drops in the rest must pull him out. Being heavier than any other man of the party I thrust a leg through one snow-bridge, but I had just fixed my ice ax in the firm abutment and was saved the inconvenience and delay of dangling by a rope in a chasm. The beauty of these cold blue ice vaults cannot be described. They are often fringed with icicles. In one place they had formed from an overhanging shelf, reached the bottom, and then the shelf had melted away, leaving the icicles in an apparently reversed condition. We passed one place where vast masses of ice had rolled down from above, and we saw how a breath might start a new avalanche. We were up in one of nature's grandest workshops.

How the view widened! How the fleeting cloud and sunshine heightened the effect in the valley below! The glorious air made us know what the man meant who every morning thanked God that he was alive. Some have little occasion to be thankful in that respect.

Here we learned the use of a guide. Having carefully chosen him, by testimony of persons having experience, we were to follow him; not only generally, but step by step. Put each foot in his track. He had trodden the snow to firmness. But being heavier than he it often gave way under my pressure. One such slump and recovery takes more strength than ten regular steps. Not so in following the Guide to the fairer and greater heights of the next world. He who carried this world and its burden of sin on his heart trod the quicksands of time into such firmness that no man walking in his steps, however great his sins, ever breaks down the track. And just so in that upward way, one fall and recovery takes more strength than ten rising steps.

Meanwhile, what of the weather? Uncertainty. Avalanches thundered from the Breithorn and Lyskamm, telling of a penetrative moisture in the air. The Matterhorn refused to take in its signal flags of storm. Still the sun shone clear. We had put in six of the eight hours' work of ascent when snow began to fall. Soon it was too thick to see far. We came to a chasm that looked vast in the deception of the storm. It was only twenty feet wide. Getting round this the storm deepened till we could scarcely see one another. There was no mountain, no sky. We halted of necessity. The guide said, "Go back." I said, "Wait." We waited in wind, hail, and snow till all vestige of the track by which we had come—our only guide back if the storm continued—was lost except the holes made by the Alpenstocks. The snow drifted over, and did not fill these so quickly.

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Not knowing but that the storm might last two days, as is frequently the case, I reluctantly gave the order to go down. In an hour we got below the storm. The valley into which we looked was full of brightest sunshine; the mountain above us looked like a cowled monk. In another hour the whole sky was perfectly clear. O that I had kept my faith in my aneroid! Had I held to the faith that started me in the morning—endured the storm, not wavered at suggestions of peril, defied apparent knowledge of local guides—and then been able to surmount the difficulty of the new-fallen snow, I should have been favored with such a view as is not enjoyed once in ten years; for men cannot go up all the way in storm, nor soon enough after to get all the benefit of the cleared air. Better things were prepared for me than I knew; indications of them offered to my faith; they were firmly grasped, and held almost long enough for realization, and then let go in an hour of darkness and storm.

I reached the Riffelhouse after eleven hours' struggle with rocks and softened snow, and said to the guide, "To-morrow I start for the Matterhorn." To do this we go down the three hundred stories to Zermatt.

Every mountain excursion I ever made has been in the highest degree profitable. Even this one, though robbed of its hoped-for culmination, has been one of the richest I have ever enjoyed.

THE MATTERHORN

The Matterhorn is peculiar. I do not know of another mountain like it on the earth. There are such splintered and precipitous spires on the moon. How it came to be such I treated of fully in *Sights and Insights*. It is approximately a three-sided mountain, fourteen thousand seven hundred and eighteen feet high, whose sides are so steep as to be unassailable. Approach can be made only along the angle at the junction of the planes.

[Illustration: The Matterhorn.]

It was long supposed to be inaccessible. Assault after assault was made on it by the best and most ambitious Alp climbers, but it kept its virgin height untrodden. However, in 1864, seven men, almost unexpectedly, achieved the victory; but in descending four of them were precipitated, down an almost perpendicular declivity, four thousand feet. They had achieved the summit after hundreds of others had failed. They had reveled in the upper glories, deposited proof of their visit, and started to return. According to law, they were roped together. According to custom, in a difficult place all remain still, holding the rope, except one who carefully moves on. Croz, the first guide, was reaching up to take the feet of Mr. Haddow and help him down to where he stood. Suddenly Haddow's strength failed, or he slipped and struck Croz on the shoulders,

knocking him off his narrow footing. They two immediately jerked off Rev. Mr. Hudson. The three falling jerked

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off Lord Francis Douglas. Four were loose and falling; only three left on the rocks. Just then the rope somehow parted, and all four dropped that great fraction of a mile. The mountain climber makes a sad pilgrimage to the graves of three of them in Zermatt; the fourth probably fell in a crevasse of the glacier at the foot, and may be brought to the sight of friends in perhaps two score years, when the river of ice shall have moved down into the valleys where the sun has power to melt away the ice. This accident gave the mountain a reputation for danger to which an occasional death on it since has added.

Each of these later unfortunate occurrences is attributable to personal perversity or deficiency. Peril depends more on the man than on circumstances. One is in danger on a wall twenty feet high, another safe on a precipice of a thousand feet. No man has a right to peril his life in mere mountain climbing; that great sacrifice must be reserved for saving others, or for establishing moral principle.

The morning after coming from Monte Rosa myself and son left Zermatt at half past seven for the top of the Matterhorn, twelve hours distant, under the guidance of Peter Knubel, his brother, and Peter Truffer, three of the best guides for this work in the country. In an hour the dwellings of the mountain-loving people are left behind, the tree limit is passed soon after, the grass cheers us for three hours, when we enter on the wide desolation of the moraines. Here is a little chapel. I entered it as reverently and prayed as earnestly for God's will, not mine, to be done as I ever did in my life, and I am confident that amid the unutterable grandeur that succeeded I felt his presence and help as fully as at any other time.

At ten minutes of two we were roped together and feeling our way carefully in the cut steps on a glacier so steep that, standing erect, one could put his hand upon it. We were on this nearly an hour. Just as we left it for the rocks a great noise above, and a little to the south, attracted attention. A vast mass of stone had detached itself from the overhanging cliff at the top, and falling on the steep slope had broken into a hundred pieces. These went bounding down the side in long leaps. Wherever one struck a cloud of powdered stone leaped into the air, till the whole mountain side smoked and thundered with the grand cannonade. The omen augured to me that the mountain was going to do its best for our reception and entertainment. Fortunately these rock avalanches occur on the steep, unapproachable sides, and not at the angle where men climb.

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How the mountain grew upon us as we clung to its sides! When the great objects below had changed to littleness the heights above seemed greater than ever. At half past four we came to a perpendicular height of twenty feet, with a slight slope above. Down this precipice hung a rope; there was also an occasional projection of an inch or two of stone for the mailed foot. At the top, on a little shelf, under hundreds of feet of overhanging rock, some stones had been built round and over a little space for passing the night. The rude cabin occupied all the width of the shelf, so that passing to its other end there was not room to walk without holding on by one's hands in the crevices of the wall. We were now at home; had taken nine hours to do what could be done in eight. What an eyrie in which to sleep! Below us was a sheer descent, of a thousand or two feet, to the glacier. Above us towered the crest of the mountain, seemingly higher than ever. The sharp shadow of the lofty pyramid lengthened toward Monte Rosa. Italy lifted up its mountains tipped with sunshine to cheer us. The Obernese Alps, beyond the Rhone, answered with numerous torches to light us to our sleep. According to prearrangement, at eight o'clock we kindled a light on our crag to tell our friends in Zermatt that we had accomplished the first stage of our journey. They answered instantly with a cheery blaze, and we lay down to sleep.

When four of us lay together I was so crowded against the wall that I thought if it should give way I could fall two thousand feet out of bed without possibility of stopping on the way. The ice was two feet thick on the floor, and by reason of the scarcity of bedding I was reminded of the damp, chilly sheets of some unaired guest-chambers. I do not think I slept a moment, but I passed the night in a most happy, thoughtful, and exultant frame of mind.

At half past three in the morning we were roped together—fifteen feet of rope between each two men—for the final three or four hours' work. It is everywhere steep; it is every minute hands and feet on the rocks; sometimes you cling with fingers, elbows, knees, and feet, and are tempted to add the nose and chin. Where it is least steep the guide's heels are right in your face; when it is precipitous you only see a line of rope before you. We make the final pause an hour before the top. Here every weight and the fear that so easily besets one must be laid aside. No part of the way has seemed so difficult; not even that just past—when we rounded a shoulder on the ice for sixty feet, sometimes not over twenty inches wide, on the verge of a precipice four thousand feet high. To this day I can see the wrinkled form of that far-down glacier below, though I took care not to make more than one glance at it.

The rocks become smoother and steeper, if possible. A chain or rope trails from above in four places. You have good hope that it is well secured, and wish you were lighter, as you go up hand over hand. Then a beautiful slope for hands, knees, and feet for half an hour, and the top is reached at half past six.

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The view is sublime. Moses on Pisgah could have had no such vision. He had knowledge added of the future grandeur of his people, but such a revelation as this tells so clearly what God can do for his people hereafter that that element of Moses's enjoyment can be perceived, if not fully appreciated. All the well-known mountains stand up like friends to cheer us. Mont Blanc has the smile of the morning sun to greet us withal. Monte Rosa chides us for not partaking of her prepared visions. The kingdoms of the world—France, Switzerland, Italy—are at our feet. One hundred and twenty snow-peaks flame like huge altar piles in the morning sun. The exhilarant air gives ecstasy to body, the new visions intensity of feeling to soul. The Old World has sunk out of sight. This is Mount Zion, the city of God. New Jerusalem has come down out of heaven adorned as a bride for her husband. The pavements are like glass mingled with fire. The gates of the morning are pearl. The walls, near or far according to your thought, are like jasper and sapphire. The glory of God and of the Lamb lightens it.

But we must descend, though it is good to be here. It is even more difficult and tedious than the ascent. *Non facilis descensus*. With your face to the mountain you have only the present surface and the effort for that instant. But when you turn your back on the mountain the imminent danger appears. It is not merely ahead, but the sides are much more dangerous. On the way down we had more cannonades. In six hours we were off the cliffs, and by half past three we had let ourselves down, inch by inch, to Zermatt, a distance of nine thousand four hundred feet.

Looking up to the Matterhorn this next morning after the climb, I feel for it a personal affection. It has put more pictures of grandeur into my being than ever entered in such a way before. It is grand enough to bear acquaintance. People who view it from a distance must be strangers. It has been, and ever will be, a great example and lofty monument of my Father's power. He taketh up the isles as a very little thing; he toucheth the mountains and they smoke. The strength of the hills is his also; and he has made all things for his children, and waits to do greater things than these.

THE GRAND CANON OF THE COLORADO RIVER

Before me lies a thin bit of red rock, rippled as delicately as a woman's hair, bearing marks of raindrops that came from the south. It was once soft clay. It was laid down close to the igneous Archaean rocks when Mother Earth was in her girlhood and water first began to flow. More clay flowed over, and all was hardened into rock. Many strata, variously colored and composed, were deposited, till our bit of beauty was buried thousands of feet deep. The strata were tilted variously and abraded wondrously, for our earth has been treated very much as the fair-armed bread-maker treats the lump of dough she doubles and kneads on the molding board. Other rocks of a much harder nature, composed in part of the shells of inexpressible multitudes of Ocean's infusoria, were laid down from the superincumbent sea. Still the delicate ripple marks were

preserved. Nature's vast library was being formed, and on this scrap of a leaf not a letter was lost.

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Beside this stone now lies another of the purest white. It once flowed as water impregnated with lime, and clung to the lower side of a rock now as high above the sea as many a famous mountain. The water gradually evaporated, and the lime still hung like tiny drops. Between the two stones now so near together was once a perpendicular distance of more than a mile of impenetrable rock. How did they ever get together? Let us see.

After the rock making, by the deposit of clay, limestone, *etc*., this vast plain was lifted seven thousand feet above the sea and rimmed round with mountains. Perhaps in being afterward volcanically tossed in one of this old world's spasms an irregular crack ripped its way along a few hundred miles. Into this crack rushed a great river, perhaps also an inland ocean or vast Lake Superior, of which Salt Lake may be a little remnant puddle. These tumultuous waters proceeded to pulverize, dissolve, and carry away these six thousand feet of rock deposited between the two stones. There was fall enough to make forty Niagaras.

I was once where a deluge of rain had fallen a few days before in a mountain valley. It tore loose some huge rocks and plunged down a precipice of one thousand feet. The rock at the bottom was crushed under the frightful weight of the tumbling superincumbent mass, and every few minutes the top became the bottom. In one hour millions of tons of rock were crushed to pebbles and spread for miles over the plain, filling up a whole village to the roofs of the houses. I knew three villages utterly destroyed by a rush of water only ten feet deep. Water and gravitation make a frightful plow. Here some prehistoric Mississippi turned its mighty furrows.

The Colorado River is one of our great rivers. It is over two thousand miles long, reaches from near our northern to beyond our southern border, and drains three hundred thousand square miles of the west side of the Rocky Mountains. Great as it remains, it is a mere thread to what it once was. It is easy to see that there were several epochs of work. Suppose the first one took off the upper limestone rock to the depth of several thousand feet. This cutting is of various widths. Just here it is eighteen miles wide; but as such rocks are of varying hardness there are many promontories that distinctly project out, say, half a mile from the general rim line, and rising in the center are various Catskill and Holyoke mountains, with defiantly perpendicular sides, that persisted in resisting the mighty rush of waters. The outer portions of their foundations were cut away by the mighty flood and, as the ages went by, occasionally the sides thundered into the chasm, leaving the wall positively perpendicular.

We may now suppose the ocean waters nearly exhausted and only the mighty rivers that had made that ocean were left to flow; indeed, the rising Sierras of some range unknown at the present may have shut off whole oceans of rain. The rivers that remained began to cut a much narrower channel into the softer sand and clay-rock below. From the great mountain-rimmed plateau rivers poured in at the sides, cutting

lateral canons down to the central flow. Between these stand the little Holyokes aforesaid, with greatly narrowed base.

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I go down with most reverent awe and pick the little ripple-rain-marked leaf out of its place in the book of nature, a veritable table of stone written by the finger of God, and bring it up and lay it alongside of one formed, eons after, at the top. They be brothers both, formed by the same forces and for the same end.

Standing by this stupendous work of nature day after day, I try to stretch my mind to some large computation of the work done. A whole day is taken to go down the gorge to the river. It takes seven miles of zigzag trail, sometimes frightfully steep, along shelves not over two feet wide, under rock thousands of feet above and going down thousands of feet below, to get down that perpendicular mile. It was an immense day's work.

The day was full of perceptions of the grandeur of vast rock masses never before suggested, except by the mighty mass of the Matterhorn seen close by from its Hoernli shoulder.

There was the river—a regular freight train, running day and night, the track unincumbered with returning cars (they were returned by the elevated road of the upper air)—burdened with dissolved rock and earth.

A slip into this river scarcely seemed to wet the foot; it seemed rather to coat it thickly with mud rescued from its plunge toward the sea. What unimaginable amounts the larger river must have carried in uncounted ages! In the short time the Mississippi has been at work it has built out the land at its mouth one hundred miles into the Gulf.

In the side canon down which we worked our sublime and toilful way it was easy to see the work done. Sometimes the fierce torrent would pile the bottom of a side canon with every variety of stone, from the wall a mile high, into one tremendous heap of conglomerate. The next rush of waters would tear a channel through this and pour millions of tons into the main river. For years Boston toiled, in feeble imitation of Milton's angels, to bring the Milton Hills into the back Bay and South Boston Flats. Boston made more land than the city originally contained, but it did not move a teaspoonful compared with these excavations.

The section traversed that day seemed while we were in it like a mighty chasm, a world half rent asunder, full of vast sublimities, but the next day, seen from the rim as a part of the mighty whole, it appeared comparatively little. One gets new meanings of the words almighty, eternity, infinity, in the presence of things done that seem to require them all.

In 1869 Major J. W. Powell, aided by nine men, attempted to pass down this tumultuous river with four boats specially constructed for the purpose. In ninety-eight days he had made one thousand miles, much of it in extremest peril. For weeks there was no possibility of climbing to the plateau above.

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Any great scene in nature is like the woman you fall in love with at first sight for some pose of head, queenly carriage, auroral flush of color, penetrative music of voice, or a glance of soul through its illumined windows. You do not know much about her, but in long years of heroic endurance of trials, in the great dignity of motherhood, in the unspeakable comfortings that are scarcely short of godlike, and in the supernal, ineffable beauty and loveliness that cover it all, you find a richness and worth of which the most ardent lover never dreamed. The first sight of the canon often brings strong men to their knees in awe and adoration. The gorge at Niagara is one hundred and fifty feet deep; it is far short of this, which is six thousand six hundred and forty. Great is the first impression, but in the longer and closer acquaintance every sense of beauty is flooded to the utmost.

The next morning I was out before “jocund day stood tiptoe on the breezy mountain tops.” I have seen many sunrises In this world and one other: I have watched the moon slowly rolling its deep valleys for weeks into its morning sunlight. I knew what to expect. But nature always surpasses expectations. The sinuosities of the rim sent back their various colors. A hundred domes and spires, wind sculptured and water sculptured, reached up like Memnon to catch the first light of the sun, and seemed to me to break out into Memnonian music. As the world rolled the steady light penetrated deeper, shadows diminished, light spaces broadened and multiplied, till it seemed as if a new creation were veritably going forward and a new “Let there be light” had been uttered. I had seen it for the first time the night before in the mellow light of a nearly full moon, but the sunlight really seemed to make, in respect to breadth, depth, and definiteness, a new creation.

One peculiar effect I never noticed elsewhere. It is well known that the blue sky is not blue and there is no sky. Blue is the color of the atmosphere, and when seen in the miles deep overhead, or condensed in a jar, it shows its own true color. So, looking into this inconceivable canon, the true color came out most beauteously. There was a background of red and yellowish rocks. These made the cold blue blush with warm color. The sapphire was backed with sardonyx, and the bluish white of the chalcedony was half pellucid to the gold chrysolite behind it. God was laying the foundation of his perfect city there, and the light of it seemed fit for the redeemed to walk in, and to have been made by the luminousness of Him who is light.

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One great purpose of this world is its use as significant symbol and hint of the world to come. The communication of ideas and feelings there is not by slow, clumsy speech, often misunderstood, originally made to express low physical wants, but it is by charade, panorama, parable, and music rolling like the voice of many waters in a storm. The greatest things and relations of earth are as hintful of greater things as a bit of float ore in the plains is suggestive of boundless mines in the upper hills. So the joy of finding one lost lamb in the wilderness tells of the joy of finding and saving a human soul. One should never go to any of God's great wonders to see sights, but to live life; to read in them the figures, symbols, and types of the more wonderful things in the new heavens and the new earth.

The old Hebrew prophets and poets saw God everywhere in nature. The floods clap their hands and the hills are joyful together before the Lord. Miss Proctor, in the Yosemite, caught the same lofty spirit, and sang:

"Perpetual masses here intone,
Uncounted censers swing,
A psalm on every breeze is blown;
The echoing peaks from throne to throne
Greet the indwelling King;
The Lord, the Lord is everywhere,
And seraph-tongued are earth and air."

THE YELLOWSTONE PARK GEYSERS

THEIR ESSENTIAL FACTS AND CAUSES

I have been to school. Dame Nature is a most kind and skillful teacher. She first put me into the ABC class, and advanced me through conic sections. The first thing in the geyser line she showed me was a mound of rock, large as a small cock of hay, with a projection on top large as a shallow pint bowl turned upside down. In the center of this was a half-inch hole, and from it every two seconds, with a musical chuckle of steam, a handful of diamond drops of water was ejected to a height of from two to five feet. I sat down with it half an hour, compelled to continuous laughter by its own musical cachinnations. There were all the essentials of a geyser. There was a mound, not always existent, built up by deposits from the water supersaturated with mineral. It might be three feet high; it might be thirty. There was the jet of water ejected by subterranean forces. It might be half an inch in diameter; it might be three hundred feet, as in the case of the Excelsior geyser. It might rise six inches; it might rise two hundred and fifty feet. There was the interval between the jets. It might be two seconds; it might be weeks or years.

[Illustration: Formation of the Grotto Geyser.]

A subsequent lesson in my Progressive Geyser Reader was the “Economic.” Here was a round basin ten feet in diameter, very shallow, with a hole in the middle about one foot across. The water was perfectly calm. But every six minutes a sudden spurt of water and steam would rise about thirty feet, for thirty seconds, and then settle economically, without waste of water, into the pool, sinking with pulsations as on an elastic cushion a foot below the bottom of the pool. One could stride the opening like a colossus for five and one half minutes without fear. He might be using the calm depth for a mirror. But stay a moment too long and he is scalded to death by the sudden outburst.

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The next lesson required more patience and gave more abundant reward. I found a great raised platform on which stood a castellated rock, more than twenty feet square, that had been built up particle by particle into a perfect solid by deposits from the fiery flood. In the center was a brilliant orange-colored throat that went down into the bowels of the earth. That was not the geyser—it was only the trump through which the archangel was to blow. I had heard the preliminary tuning of the instrument.

The guide book said the grand play of this “Castle” geyser began from eight to thirty hours after a previous exhibition, and was preceded by jets of water fifteen to twenty feet high, and that these continued five or six hours before the grand eruption. I hovered near the grand stand till the full thirty hours and the six predictive hours were over, and then, as the thunder above roared threateningly and the rain fell suggestively, I took a rubber coat and camped on the trail of that famous spouter.

Geysers are more than a trifle freaky. “Old Faithful” is a notable exception. Every sixty-five minutes, with almost the regularity of star time, he throws his column of hissing water one hundred and fifty feet high. Others are irregular, sometimes playing every three hours for a few times, and then taking a rest for three or more days. This Castle geyser is not registered to be quiet more than thirty hours, nor to indulge in preparatory spouts for more than six hours. When I finally camped to watch it out all these premonitory symptoms had been duly exhibited. I first carefully noted the frequency and height of the spouts, that any change might foretell the grand finale. There were ten spouts to the minute, and an average height of twenty feet. Hours went by with no hint of a change: ten to the minute, twenty feet in height. People by the dozen came and asked when it would go off. I said, “Liable to go any minute; it is long past due now.” Stage loads of tourists, scheduled to run on time, drove up, waited a few minutes, and drove on, as if the grand object of the trip was to make time—not to see the grandeur they had come a thousand miles to enjoy. A photographer set up his camera to catch a shadow of the great display. He stood, sometimes air-bulb in hand, an hour or two, then folded his camera tent and stole away. Five hours had passed and night was near. Everybody was gone. I lay down on the ground to convince myself that I was perfectly patient. I attained so nearly to Nirvana that a little ground squirrel came and ran over me, kissing my hand in a most friendly way.

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Six hours of waiting were nearly over when, without a single previous hint of change, one descending spout was met by an ascending one, and a vast column of hissing water rose, with a sound of continuous thunder, one hundred feet in air; and stood there like a pillar of cloud in the desert. The air throbbed as in a cannonade, and the sun brushed away all clouds as if he could not bear to miss a sight he had seen perhaps a million times. Then the top of this upward Niagara bent over like the calyx of a calla, and the downward Niagara covered all that elevated masonry with a rushing cascade. Shifting my position a little, I could see that the sun was thrilling the whole glorious outpour with rainbows. At such times one can neither measure nor express emotions by words. In the thunder which anyone can hear there is always, for all who can receive it, the ineffably sweet voice of the Father saying, “Thou art my beloved son, and all this grand display is for thy precious sake.”

In sixteen minutes the flow of waters ceased, and a rush of saturated steam succeeded. At the same time the fierce swish of ascending waters and of descending cascades ceased, and a clear, definite note, as of a trumpet, exceeding long and loud, was blown. No archangel could have done better. As the steam rolled skyward it was condensed, and a very heavy rain fell on about an acre at the east as it was drifted by the air. It looked more like lines of water than separated drops. I found it thoroughly cooled by its flight in the upper air.

I climbed the huge natural masonry, and stood on the top. I could have put my hand into the hot rushing of measureless power. What a sight it was! There were the brilliant colors of the throat, open, three feet wide, and the dazzling whiteness of the steam. At thirty-two minutes from the beginning the steam suddenly became drier, like that close to the spout of a kettle, or close to the whistle of an engine. All pure steam is invisible. At the same time the note of the trumpet distinctly changed. The heavy rain at the east as suddenly stopped. The air could absorb the present amount of moisture. One could see farther down the terrible throat that seemed about to be rent asunder. The awful grandeur was becoming too much for human endurance. The contorted forms of rocks on the summit began to take the forms and heads of dragons, such as the Chinese carve on their monuments. The awful column began to change its effect from terror to fascination, and I knew how Empedocles felt when he flung himself into the burning Aetna. It was time to get down and stand further off.

[Illustration: Bee-Hive Geyser.]

The long waiting had been rewarded. “To patient faith the prize is sure.” The grand tumult began to subside. It was beyond all my expectations. Nature never disappoints, for she is of God and in her he yet immanently abides. The next day the sky and all the air were full of falling rain. How could it be otherwise? It was the geyser returning to earth. I sought the place. The awful trumpet was silent, and the steam exhaled as gently as a sleeping baby’s breath.

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Only one more lesson will be recited at present. I had just arrived in camp when they told me that the Splendid geyser, after two days of quiet, was showing signs of uneasiness. I immediately went out to study my lesson. There was a little hill of very gentle slopes, a little pool at the top, three holes at the west side of it, with a dozen sputtering hot springs scattered about, while in a direct line at the east, within one hundred and forty feet, were the Comet, the Daisy, and another geyser. The Daisy was a beauty, playing forty feet high every two or four hours. All the slopes were constantly flowing with hot water. This general survey was no sooner taken than our glorious Splendid began to play. The roaring column, tinted with the sunset glories, gradually climbed to a height of two hundred feet, leaned a little to the southeast, and bent like a glorious arch of triumph to the earth, almost as solid on its descending as on its ascending side. No wonder it is named “Splendid.”

Whoever has studied waterfalls of great height—I have seen nearly forty justly famous falls—has noticed that when a column or mass of water makes the fearful plunge smaller masses of water are constantly feathered off at the sides and delayed by the resistance of the air, while the central mass hurries downward by its concentrated weight. The general appearance is that of numerous spearheads with serrated edges, feathered with light, thrust from some celestial armory into the writhing pool of agonized waters below. In the geyser one gets this effect both in the ascending and in the descending flood.

Four times that first night dear old Splendid lured me from my bed to watch her Titanic play in the full light of the moon. During all this time not a hot spring ceased its boiling, nor a smaller geyser its wondrous play, for this gigantic outburst of power that might well have absorbed every energy for a mile around. Obviously they have no connection. Then my beloved Splendid settled into a three-days’ rest.

These are the essential facts of geyser display. There are very many variations of performance in every respect, I have seen over twenty geysers in almost jocular, and certainly in overwhelmingly magnificent, activity.

“To him who in the love of nature holds
Communion with her visible forms, she speaks
A various language.”

WHAT ARE THE CAUSES?

What is the power that can throw a stream of water two by six feet over the tops of the highest skyscrapers of Chicago? It is heat manifested in the expansive power of steam. Scientists have theorized long and experimented patiently to read the open book of this tremendous manifestation of uncontrollable energy. At first the form and action of a teakettle was supposed to be explanatory. Everyone knows that when

steam accumulates under the lid it forces a gentle stream of water from the higher nozzle. This fact was made the basis of a theory to account for geysers by Sir George Mackenzie in 1811. But to suppose that nature has gone into the teakettle manufacturing business to the extent of thirty such kettles in a space of four square miles was seen to be preposterous. So the construction theory was given up.

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But suppose a tube (how it is made will be explained later), large or small, regular or irregular, to extend far into the earth, near or through any great source of heat resulting from condensation, combustion, chemical action, or central fire. Now suppose this tube to be filled with water from surface or subterranean sources. Heat converts water, under the pressure of one atmosphere, or fifteen pounds to the square inch, into steam at a temperature of two hundred and twelve degrees. But under greater pressure more heat is required to make steam. The water never leaps and bubbles in an engine boiler. The awful pressure compels it to be quiet. A cubic inch of water will make a cubic foot—one thousand seven hundred and twenty-eight times as much—of steam under the pressure of one atmosphere. But under the pressure of a column of water one thousand feet high, giving a pressure of four hundred and thirty-two pounds to the square inch at the bottom, water becomes steam, if at all, only by great heat. Every engineer knows that the pressure exerted by steam increases by great geometrical ratios as the heat increases by small arithmetical ratios. Steam made by two hundred and twelve degrees exerts a pressure, as we have said, of fifteen pounds.

To simply double the two hundred and twelve degrees of heat increases the steam pressure twenty-three times.

Now suppose the subterranean tube or lake of Old Faithful to be freshly filled with its million gallons of water. Sufficient heat makes steam under any pressure. It rises up the tube and is condensed to water again by the colder water above. Hence no commotion. But the whole volume of water grows hotter for an hour. When it is too hot to absorb the steam, and the tube is too narrow to let the amount made bubble up through the water, it lifts the whole mass with a sudden jerk. The instant the pressure of the water is taken off in any degree, the water below, that was kept water by the pressure, breaks into steam most voluminously, and the measureless power floods the earth and sky with water and steam.

It is also known that superheated steam suddenly takes on such great power that no boiler can hold it. Once let the water in a boiler get very low and no boiler can hold the force of the resultant superheated steam. The same heat that, applied to water, gives perfect safety, applied to steam gives utter destruction. Hence the amazing force of the vast jets of the geyser that follow the first spurts.

As soon as the steam is blown off the subterranean waterworks fill the tube and the process is repeated.

This modus operandi was first proposed as a theory by Bunsen in 1846, and later was demonstrated by the artificial geyser of Professor J. H. J. Muller, of Freiburg.

[Illustration: Pulpit Terrace and Bunsen Peak.]

MOUNDS OF MINERAL DEPOSITS

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I have the extremely difficult task of representing emotions by words—glories of color and form seen by the eye by symbols meant to be addressed to the ear. Before seeking to describe the diverse colors made largely by one substance, let us remember that while silica, the principal part of these water-built mounds, is one of the three parts of granite, namely, the white crystal quartz, it is also the substance of the beautifully variegated jasper, the lapis lazuli, the green malachite, and the opal, with its cloudy milk-whiteness through which flashes its heart of fire. Silica and alumina combine to make common clay, but alumina forms itself into the red ruby, the golden-tinted topaz, the violet oriental amethyst, the red, white, yellow, and violet sapphire, and the beautiful green emerald. With substances of such rare capabilities we may expect rich results in color and form.

We turn now to deposits from water of these two substances, especially the first. About the Old Faithful geyser is a mound about one hundred and forty-five feet broad at the base, twelve feet high, jeweled over with pools of beauty of every shape, beaded and fretted with glories of color never seen before except in the sky. How were they made?

Water is a general solvent. It can take into its substance several similar bulks of other substances without greatly increasing its own, some actually diminishing it. Hot alkaline water will dissolve even silica rock. When water is saturated with sugar, salt, or other substance, if a little or much water is evaporated some of the saturating substance must be deposited as a solid. All crystals, as quartz or diamonds, have been made by deposits from water. Hot water can hold in solution much more of a solid than cold water. Therefore, when hot water comes out of the earth and is cooled, some of the saturating substance must be deposited as a solid. It is done in various ways, especially two.

Suppose a little pool with perpendicular sides, say twenty feet across. It leaps and boils two feet high. It deposits nothing till the water comes to the cooling edge. Then it builds up a wall where it overflows, and wherever it flows it builds. The result is that you walk up the gentle slopes of a broad flat cone, and find the little lakelet in a gorgeous setting, perfectly full at every point of the circumference. If there is but little overflow, the result may be to deposit all the matter where it first cools, and make a perpendicular wall around the cup two or ten feet high. If the overflow is too much to be cooled at once, the deposit may still be made fifty or one hundred feet from the point of issue. If the overflow is sufficient, it may be building up every inch of a vast cone at once, every foot being wet.

[Illustration: The Punch Bowl, Yellowstone Geysers.]

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Many minerals are held in solution and are deposited at various stages of evaporation. Let us suppose the lake to have the bottom sloping toward the abysmal center; the different minerals will be assorted as if with a sieve. At the Sunlight Basin the edge is as flaming red as one ever sees in the sunlit sky. And every color ever seen in a sunset flames almost as brilliantly in the varying depths. Suppose a low cone to be flooded only occasionally, as in the case of the Old Faithful geyser. The cooled water falling from the upper air builds up, under the terrible drench of the cataract, walls three or four inches high, making pools of every conceivable shape, a few inches deep, in which are the most exquisite and varied colors ever seen by mortal eye. You walk about on these dividing walls and gaze into the beaded and impearled pools of a hundred shades of different colors, never equaled except by that perpetual glory of the sunset.

Consider the case of a pool that does not overflow. Just as lakes that have no outlet must grow more and more salt till some have become solid salt beds, so must this pool, tossing its hot waves two or three feet high, evaporate its water and deposit its solids. Where? First, against the cooler sides of the rock under the water, tending to reduce the opening to a mere throat. Second, each wavelet tossed in air is cooled, and deposits on the edge, solid as quartz, a crust that overhangs the pool and tends to close it over as with hot ice. It may build thus a mound fifteen feet high with an open throat in the middle. Thus the pool has constructed an intermittent geyser. If the water supply continues, it also destroys itself. The throat closes up by its own deposits. It is a case of geyseral membranous croup.

I exceedingly longed to try vivisection on a geyser, or at least take one of half a hundred, drain it off, and make a post-mortem examination. On my very last day I found opportunity. I found a dead geyser, though not by any means yet cold. It was still so hot that people had given it an infernal name. I squeezed myself down through its hot throat, which seemed a veritable open sepulcher, and found a cave about twenty-five feet deep, twelve feet wide, and about sixty feet long. It was elliptical in form, the sides coming together at a sharp angle at the ends, bottom, and top. The way down to the fiery heart of the earth had simply grown up by deposits of silex on the sides and at the bottom. The water had evaporated by the intense heat, and I was in the hot hollow that had once held an earthquake and volcano. When I squeezed up to the blessed upper air I was glad there was no help from below.

I could tell of mounds that grew so fast as to inclose the limbs of a tree, making the firmest kind of a ladder by which I climbed to the top; of floods that overflowed acres of forest, leaving every tree firmly planted in solid rock; of mounds hundreds of feet high, covering twenty acres with forms of indescribable beauty—but I despair. The half has not been told. It cannot be. Great and marvelous are all Thy works, Lord God Almighty! In wisdom hast Thou made them all.

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Emerson says: "Whilst common sense looks at things or visible nature as real and final facts, poetry, or the imagination which dictates it, is a second sight, looking through these, and using them as types or words for thoughts which they signify." Using these faculties and not mere eyesight, one must surely say: "Since this world, in power, fineness, finish, beauty, and adaptations not only surpasses our accomplishment, but also is past our finding out to its perfection, it must have been made by One stronger, finer, and wiser than we are."

SEA SCULPTURE*

Reprinted from _The Chautauquan_.

When the Russians charged on the Grivitza redoubt at Plevna they first launched one column of men that they knew would be all shot down long before they could reach it. But they made a cloud of smoke under the cover of which a second column was launched. They would all be shot down. But they carried the covering cloud so far that a third column broke out of it and successfully carried the redoubt. They carried it, but ten thousand men lay on the death-smitten slope.

So the great ocean sends eight or ten thousand columns a day to charge with flying banners of spray on the rocky ramparts of the shore at Santa Cruz, California.

There are not many things in the material world more sublime than a thousand miles of crested waves rushing with terrible might against the rocky shore. While they are yet some distance from the land a small boat can ride their foaming billows, but as they approach the shallower places they seem to take on sudden rage and irresistible force. Those roaring waves rear up two or three times as high. They have great perpendicular fronts down which Niagaras are pouring. The spray flies from their tops like the mane of a thousand wild horses charging in the wind. No ship can hold anchor in the breakers. They may dare a thousand storms outside, but once let them fall into the clutch of this resistless power and they are doomed. The waves seem frantic with rage, resistless in force; they rush with fury, smite the cliffs with thunder, and are flung fifty feet into the air; with what effect on the rocks we will try to relate.

[Illustration: "The Breakers," Santa Cruz, Cal.]

No. 1 of our illustrations shows "The Breakers," a two-story house of that name where hospitality, grace, and beauty abide; where hundreds of roses bloom in a day, and where flowers, prodigal as creative processes, abound. The breakers from which the house is named are not seen in the picture. When the wind has been blowing hard, maybe one hundred miles out at sea, they come racing in from the point, feather-crested, a dozen at once, to show how rolls the far Wairoa at some other world's end. All these pictures are taken in the calm weather, or there would be little seen besides

the great leaps of spray, often fifty feet high. At the bottom of the cliff appear the nodules and bowlders that were too hard to be bitten into dust and have fallen out of the cliff, which is fifty feet high, as the sea eats it away. Some of these are sculptured into the likeness effaces and figures, solemn and grotesque. It is easy to find Pharaoh, Cleopatra, Tantalus, represented here.

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This house is at the beginning of the famous Cliff Drive that rounds the lighthouse at the point and stretches away for miles above the ever-changing, now beautiful, now sublime, and always great Pacific, that rolls its six thousand miles of billows toward us from Hong Kong. Occasionally the road must be set back, and once the lighthouse was moved back from the cliffs, eaten away by the edacious tooth of the sea.

As Emerson says, “I never count the hours I spend in wandering by the sea; like God it useth me.” There is a wideness like his mercy, a power like his omnipotence, a persistence like his patience, a length of work like his eternity.

The rocks of Santa Cruz, as in many other places, were laid in regular order, like the leaves of a book on its side. But by various forces they have been crumbled, some torn out, and in many places piled together. These layers, beginning at the bottom, are as follows; (1) igneous granite, unstratified; (2) limestone laid down from life in the ocean, metamorphosed by heat and all fossils thereby destroyed; (3) limestone highly crystallized, composed of fossil shells and very hard; (4) sandstone, made under the sea from previous rock powdered, having huge concretionary masses with a shell or a pebble as a nucleus around which the concretion has taken place; (5) shale from the sea also; (6) conglomerate, or drift, deposited by ice in the famous glacial cold snap; (7) alluvium soil deposited in fresh water and composed partly of organic matter. In our second illustration some of these layers, or strata, may be distinguished.

[Illustration: The Work and the Worker, Santa Cruz, Cal.]

When the awful blows of the sea smite the rock, if it finds a place less hard than others, it wears into it a slight depression, after half a hundred thousand strokes, more or less, and ever after, as the years go by, it drives its wedges home in that place. A shallow cave results. Then the waters converge on the sides of the cave and meet with awful force in the middle. Thus a tunnel is excavated, like a drift in a mine, each wave making the tremendous charge and the reflowing surges bringing away all the detritus. This tunnel may be driven or excavated two hundred feet inland, under the shore. At each inrush of the wave the air is terribly condensed before it. It seeks outlet. And so it happens that the air is driven up through some crack in the rock and the superincumbent earth, one or two hundred feet from the shore, and a great hole appears in the ground from twenty to seventy feet deep. Then the water spouts fiercely up and returning carries back the earth and broken rock into the sea.

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No. 3 of the illustrations here given represents such a great excavation one hundred feet back from the shore. It is one hundred and fifty feet long by ninety wide and over fifty feet deep. All the material had been carried out to sea by the refluent wave. On the natural bridge seen in front the great crowd in Broadway, New York, might pass or a troop of cavalry could be maneuvered. Through the arch a ship with masts thirty feet high might enter at high tide. Through the abutment of the arch where the afternoon sun pours its brightness the waves have cut other arches not visible in the picture. When the arches become too many or too wide the natural bridge will fall and be carried out to sea like many another.

[Illustration: A Natural Bridge, Santa Cruz, Cal.]

But what does the sea do with the harder parts of the cliff? Its waves wear away the rock on each side and leave one or more long fingers reaching out into the sea. The wear and tear on such a projection is immense. A strong swimmer may play with the breakers away from the cliff. At exactly the right moment he may dive headlong through the pearly green Niagara that has not yet fallen quite to his head and may sport in the comparatively quiet water beyond, while the wild ruin falls with a sound of thunder on the beach. But let him once be caught and dashed against the rocks and there is no more life or wholeness of bones within him.

In the swirl of converging currents between two rocky projections, as the coarse sand and gravel is surged around a few hundred thousand times, there is a great tendency to wear through the wall of the projecting finger. It is often done. Illustration No. 4 shows at low tide such a projection cut through. Since the picture was taken the bridge has fallen, the detritus been carted away by the waves, and the pier stands lonely in the sea.

[Illustration: An Excavated Arch, Santa Cruz, Cal.]

No. 5 shows one bridge exceedingly frail and another more substantial nearer the famous Cliff Drive. I go to the frail one every year with anxiety lest I shall find it has been carried away. How I wish I could show my readers the delicate sculpture and carving further back, nearer yet to the drive. But note the various strata, the rocks worn to a point as even the milder waves run over them; note the cracks that tell of the awful push and stress of the titanic struggle.

[Illustration: A Double Natural Arch, Santa Cruz, Cal.]

Illustration No. 6 shows three such under-hewn arches. The long projection of rock is so curved as to prevent the arches being fully seen in any one view. I have waded and swam through these rocky vistas, and there, where any more than moderate waves would have mangled me against the tusks of the cruel rocks, I have found little specimens of aquatic life by the millions, clinging fast to the rocks that were home to

them and protecting themselves by taking lime out of the water and building such a solid wall of shell that no fierceness of the wildest storm could work them harm. All these seek their food from Him who feeds all life, and he heaves the ocean up to their mouths that they may drink.

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[Illustration: A Triple Natural Arch, Santa Cruz, Cal.]

No. 7 shows what has been a quadruple arch, only one part of which is still standing. Out in the sea, lonely and by itself, appears a pier, scarcely emergent from the waves, which once supported an arch parallel to the one now standing and also one at right angles to the shore. The one now standing makes the fourth. But the ever-working sea carves and carries away arch and shore alike. At some points a careful and even admiring observer sees little change for years, but the remorseless tooth gnaws on unceasingly.

[Illustration: Remains of a Quadruple Natural Arch, Santa Cruz, Cal.]

On the right near the point is seen a board sign. It says here, as in many other places, “Danger.” Sometimes two converging waves meet at the land, rise unexpectedly, sweep over the point irresistibly, and carry away anyone who stands there. One large and two small shreds of skin now gone from the palm of my left hand give proof of an experience there that did not result quite so disastrously.

The illustration facing page 188 is another example of an arch cut through the rocky barrier of the shore. But in this case the trend of the less hard rock was at such an angle to the shore that the sea broke into the channel once more, and then the combined waves from the two entrances forced the passage one hundred and forty paces inland. It terminates in another natural bridge and deep excavation beyond, which are not shown in the picture.

[Illustration: Arch Remains Side Wall Broken, Santa Clara, Cal.]

What becomes of this comminuted rock, cleft by wedges of water, scoured over by hundreds of tons of sharp sand? It is carried out by gentle undercurrents into the bay and ocean, and laid down where winds never blow nor waves ever beat, as gently as dust falls through the summer air. It incloses fossils of the plant and animal life of to-day. There rest in nature’s own sepulcher the skeletons of sharks and whales of to-day and possibly of man. Sometime, if the depths become heights, as they have in a thousand places in the past, a fit intelligence may read therein much of the present history of the world. We say to that coming age, as a past age has said to us, “Speak to the earth and it shall teach thee, and the fishes of the sea shall declare unto thee.”

THE POWER OF VEGETABLE LIFE

I have a great variety of little masses of matter—some small as a pin’s blunt point, and none of them bigger than a pin’s head. They are smooth, glossy, hard, exceedingly beautiful under the microscope, and clearly distinguishable one from another. They have such intense individuality, are so self-assertive, that by no process can those of

one kind be made to look or act like those of another. These little masses of matter are centers of incredible power. They are seeds.

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Select two for examination, and, unfolding, one becomes grass—soft, succulent, a carpet for dainty feet, a rest for weary eyes, part food, but mostly drink, for hungry beasts. It exhausts all its energy quickly. Grass today is, and to-morrow is cut down and withered, ready for the oven.

Try the other seed. It is of the pin head size. It is dark brown, hard-shelled, dry, of resinous smell to nostrils sensitive as a bird's. The bird drops it in the soil, where the dews fall and where the sun kisses the sleeping princesses into life.

Now the latent powers of that little center of force begin to play. They first open the hard shell from the inside, then build out an arm white and tender as a nerve fiber, but which shall become great and tough as an oak. This arm shuns the light and goes down into the dark ground, pushing aside the pebbles and earth. Soon after the seed thrusts out of the same crevice another arm that has an instinct to go upward to the light. Neither of these arms is yet solid and strong. They are beyond expression tender, delicate, and porous, but the one is to become great roots that reach all over an acre, and the other one of California's big trees, thirty feet in diameter and four hundred feet high.

How is it to be done? By powers latent in the seed developing and expanding for a thousand years. What a power it must be!

First, it is a power of selection—might we not say discrimination? That little seed can never by any power of persuasion or environment be made to produce grass or any other kind of a tree, as manzanita, mango, banyan, catalpa, *etc*., but simply and only *sequoia gigantea*.

There are hundreds of shapes and kinds of leaves with names it gives one a headache to remember. But this seed never makes a single mistake. It produces millions of leaves, but every one is awl-shaped—subulate. Woods have many odors—sickening, aromatic, balsamic, medicinal. We go to the other side of the world to bring the odor of sandal or camphor to our nostrils. But amid so many odors our seed will make but one. It is resinous, like some of those odors the Lord enjoyed when they bathed with their delicious fragrance the cruel saw that cut their substance, and atmosphered with new delights the one who destroyed their life. The big tree, with subtle chemistry no man can imitate, always makes its fragrance with unerring exactness.

[Illustration: The Big Trees.]

There are thousands of seeds finished with a perfectness and beauty we are hardly acute enough to discover. The microscopist revels in the forms of the dainty scales of its armor and the opalescent tints of its color. The sunset is not more delicate and exquisite. But the big tree never makes but one kind of seed, and leaves no one of its thousands unfinished.

The same is true of bark, grain of wood, method of putting out limbs, outline of the mass, reach of roots, and every other peculiarity. It discriminates.

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But how does it build itself? Myriads of rootlets search the surrounding country for elements it needs for making bark, wood, leaf, flower, and seed. They often find what they want in other organizations or other chemical compounds. But with a power of analytical chemistry they separate what they want and appropriate it to their majestic growths. But how is material conveyed from rootlet to veinlet of leaf hundreds of feet away? The great tree is more full of channels of communication than Venice or Stockholm is of canals, and it is along these watery ways of commerce that the material is conveyed. These channels are a succession of cells that act like locks, set for the perpendicular elevation of the freight. The tiny boats run day and night in the season, and though it is dark within, and though there are a thousand piers, no freight that starts underground for a leaf is ever landed on the way for bark or woody fiber. Freight never goes astray, nor are express packages miscarried. What starts for bark, leaf, fiber, seed, is deposited as bark, leaf, fiber, seed, and nothing else. There are hundreds of miles of canals, but every boat knows where to land its unmarked freight. Curious as is this work underground, that in the upper air is more so. The tree builds most of its solid substance from the mobile and tenuous air. Trees are largely condensed air. By the magic chemistry of the sunshine and vegetable life the tree breathes through its myriad leaves and extracts carbon to be built into wood. Had we the same power to extract fuel from the air we need not dig for coal.

In doing this work the power of life in the tree has to overcome many other kinds of force. There is the power of cohesion. How it holds the particles of stone or iron together! You can hardly break its force with a great sledge. But the power of life in the tree, or even grass, must master the power of cohesion and take out of the disintegrating rock what it wants. So it must overcome the power of chemical affinity in water and air. The substances it wants are in other combinations, the power of which must be overcome.

Gravitation is a great power, but the thousand tons of this tree’s vast weight must be lifted and sustained in defiance of it. So for a thousand years gravitation sees the tree rise higher and higher, till the great lesson is taught that it is a weakling compared with the power of life. There is not a place where one can put his finger that there are not a dozen forces in full play, every one of which is plastic, elastic, and ready to yield to any force that is higher. So the tree stands, not mere lumber and cordwood, or an obstacle to be gotten rid of by fire, but an embodiment of life unexhausted for a thousand years. The fairy-fingered breeze plays through its myriad harp strings. It makes wide miles of air aromatic. Animal life feeds on the quintessence of life in its seeds. But most of all it is an object lesson that power triumphs over lesser power, and that the highest power has dominion over all other power.

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The great power of vegetable life was shown under circumstances that seemed the least favorable in the following experiment:

In the Agricultural College at Amherst, Mass., a squash of the yellow Chili variety was put in harness in 1874 to see how much it would lift by its power of growth.

[Illustration: Yellow Chili Squash in Harness.]

It was not an oak or mahogany tree, but a soft, pulpy, squashy squash that one could poke his finger into, nourished through a soft, succulent vine that one could mash between finger and thumb. A good idea of the harness is given by the illustration. The squash was confined in an open harness of iron and wood, and the amount lifted was indicated by weights on the lever over the top. There were, including seventy nodal roots, more than eighty thousand feet of roots and rootlets. These roots increased one thousand feet in twenty-four hours. They were afforded every advantage by being grown in a hot bed. On August 21 it lifted sixty pounds. By September 30 it lifted a ton. On October 24 it carried over two tons. The squash grew gnarled like an oak, and its substance was almost as compact as mahogany. Its inner cavity was very small, but it perfectly elaborated its seeds, as usual.

The lever to indicate the weight had to be changed for stronger ones from time to time. More weights were sought. They scurried through the town and got an anvil and pieces of railroad iron and hung them at varying distances, as shown in the cut. By the 31st of October it was carrying a weight of five thousand pounds. Then owing to defects of the new contrivance the rind was broken through without showing what might have been done under better conditions. Every particle of the squash had to be added and find itself elbow room under this enormous pressure. But life will assert itself.

[Illustration: Squash in Cage.]

No wonder that the Lord, seeking some form of speech to represent his power in human souls, says, “I am the vine, ye are the branches.” The tremendous life of infinite strength surges up through the vine and out into all branches that are really vitally attached. No wonder that much fruit is expected, and that one who knew most of this imparted power said, “I can do all things through Christ which strengtheneth me.”

SPIRITUAL DYNAMICS*

Reprinted from _The Study_.

Will God indeed dwell upon the earth? asked Solomon. Will God indeed work with man on the earth? asks the pushing, working spirit of to-day. Has man a right to expect a special lending of the infinite power to help out his human endeavors? Does God put special forces to open some doors, close others, influence some men to come to his

help, hinder others, bring to bear influences benign, restrain those malign, and invigorate a man's own powers so that his arm has the strength of ten, because his heart is pure enough for God to work in it and through it? If this is so, in what fields, under what conditions, to what extent, and in accordance with what laws may we expect aid?

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First, it is evident that there is power not ourselves. We did not make this world. We did not put into it even the lowest force, gravitation. It is more than our minds can compass to measure its power. We have no arithmetic to tell its power on every mote in the sunbeam, or flower, or grain-head bowing toward the earth, tree brought down with a crash, or avalanche with thunder. Much less can we measure the power that holds the earth to the sun spite of its measureless centrifugal force. We did not make the next highest force, cohesion. The particles of rock and iron cohere with so great an energy that gravitation cannot overcome it. But it is not by our energy. We did not make the next highest force, chemical affinity, that masters both gravitation and cohesion. Water, the result of chemical affinity between oxygen and hydrogen, can be rent into its constituent elements with nothing less than a stream of lightning. We did not make the next highest force, vegetative life. That masters gravitation, and lifts up the tree in spite of it; masters cohesion—the tree's rootlets tear asunder the particles of stone; masters chemical affinity—it takes the oxygen from air and water. We did not create that force, measureless to our minds. We say it must have come out of some omnipotence greater than all of them. The conclusion of all minds is, there is a power not ourselves.

It is unthinkable that these forces before mentioned should have originated themselves. It is equally so that they could maintain and continue themselves. There must be some continual upholding by a word of power.

It is equally plain that there is intelligence, thought, and plan behind these forces. They are not blind Samsons grinding in a prison-house, and liable at any moment to bring down in utter ruin every pillar of the universe on which they can put their hands.

If intelligent and planful, there must be personality. We may as well call it by the name by which it is universally known, God.

Now does this intelligent and powerful personality know our plans and lend his powers to the accomplishment of our purposes? It is better to put it the other way. Mr. Lincoln taught us the truer statement when one said to him, in the awful anxiety of the war, "I think God is on our side;" he answered, "My great concern is to know if we are on God's side." So our question is better thus: Does this intelligent, powerful personality accept and use our energy in the accomplishment of his plans?

That will depend on what he wants done. If he only wants mountains lifted, he can put the shoulder of an earthquake under the strata of a continent and tilt them up edgewise, or toss up a hundred miles of strata and let them come down the other side up. If he wants mountains carried hence and cast into the sea, he can bring rivers to carry for thousands of years numberless tons. If he wants worlds held in rhythmic relations to their sun, he can take gravitation. Man is of no use; he cannot reach so far.

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But if this being has anything to do that he cannot do, he will gladly welcome man's aid. Has he? Yes. Obviously he wants things done he cannot do alone. Worlds are dead. Trees do not think. Morning stars may sing together, but they cannot love. None of them have character. None of them have conscious responsiveness to the full tides of power and love that flush the universe. None of them are permanent, or worth keeping forever. They are only scaffolding. He wants something greater than he can make; something as great as God and man and angels together can make. He wants not mere matter acted upon from without, but intelligences active in themselves; wants not mere miles of granite, but hearts responsive to love, and character that is sturdier than granite, more enduring than the hills that seem to be everlasting, and of so great a price that a whole world is of less value than a single soul, and of such permanence that it shall flourish in immortal youth when worlds, short-lived in comparison, shall have passed away. God can make worlds in plenty, but he wants something so much better that they shall be mere parade-grounds for the training of his armies.

Are there proofs that God's forces are cooperating with ours? Many. Gravitation holds us to the earth. We do not drift, all sides up successively, in space or chaos. We never want a breath but there are oceans of it rushing to answer our hunger for it.

But especially do we undertake all our more definite efforts with a full expectation of the aid of the forces without us. Man takes to agriculture with a relish that indicates that the soil and he are akin. He expects all its energies to cooperate with him. He plants the grain or seed expecting that all its vegetative forces will cowork with his plans. Every energy of earth, air, water, and the far-off sun work into his plans as if they had no other end in all their being. If a man wants a house, he expects the solidity of the rock, all the adaptations of wood that has been growing for a century, expects the beauty of the fir tree, the pine, and the box to come together to beautify the place of his dwelling.

There are other forces into which man can put his scepter of power and hand of mastery. They all work for and with him. Does he want his burdens carried? The river will convey the Indian on a log or the armaments of the greatest nations. The wind fits itself into the shoulder of his sail on the sea, and steam does more work on the land than all the human race together. Does he want swiftness? The lightning comes and goes between the ends of the earth saying, "Here am I." Obviously all these kinds of forces are always on hand to work into man's plans.

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Is not our whole question settled? If these fundamental forces, these oceans of air and energy, forces so great that man cannot measure them, so delicate and fine that man does not discover them in thousands of years, are all waiting and palpitating to rush into the service of man to advance his plans, and hint of plans larger than he ever dreamed, until he grows great by handling these ineffable factors, how can it be otherwise than that the energies, thoughts, and loves back of these forces, and out of which they come, and of which they are the visible signs and exponents, are working together with man? Then, in all probability, nay in all certainty, all other forces, whether they be thrones or dominions, principalities or powers, things present or things to come, will also lend all their energies to the help of man. God does not aid in the lowest and leave us to ourselves in the highest. He does not feed the body and let the soul famish, does not help us to the meat that perishes and let us starve for the bread of eternal life.

Scripture passages, literally thousands in number, proclaim God's control of the regular operations of nature, his sovereignty over birth, life, death, disease, afflictions, and prosperity, over what we call accident, his execution of righteous retributions, bringing of deliverance, setting up thrones, and casting down princes. He upholds all things by the direct exercise of his power. "The uniformities of nature are his ordinary method of working; its irregularities his method upon occasional condition; its interferences his method under the pressure of a higher law." There can be no general providence which is not special, no care for the whole which does not include care for all the parts, no provided safety for the head which does not number all the hairs. The Old Testament doctrine of a special and minute providence over the chosen nation is expanded by Christ's loving teaching and ministrations into an equal care for the personal individual (Matt. vii, 11; xviii, 19; Heb. iv, 16). The cold glacial period of human fear that poured its ice floe over the mind of man, making him feel like an orphaned race in a godless world, has retired before the gentle beams of the Sun of Righteousness, and the winter is past, the flowers appear on the earth, the time of the singing of birds and hearts has commenced.

It is everywhere recognized that the great outcome of a man's life is not the title to a thousand acres. He is soon dispossessed. It is not all the bonds and money he can hold. A dead man's hands are empty. It is not reputation that the winds blow away. But it is character that he acquires and carries with him. He has a fidelity to principle that is like Abdiel's. He is faithful among the faithless. He has allegiance to right that the lure of all the kingdoms of the earth cannot swerve for a moment. He counts soul so much above the body that no fiery furnaces, heated seven times hotter than they are wont, sway him for a moment from adherence to the interests of soul as against even the existence of the body.

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Now, how has such an eminence of character been attained? Not altogether by individual evolution. Ancestral tendencies, parental example, the great force of strong, eternal principles, the moral muscle acquired in the gymnasium of temptation, and confessedly and especially a spiritual force vouchsafed from without, have wrought out this greatest result of heaven and earth. Of some men you expect nothing but goodness and greatness. They would belie all the tendencies of their blood to be otherwise than good. Some are constantly trained under the mighty influences of great principles that sway men as much as gravitation sways the worlds. What could be expected of the men of ’76 when the air was electric with patriotism? What could be expected of men whose childhood was filled with the sacrifices of men who made themselves pilgrims and strangers over the earth, from England to Holland and thence over the drear and inhospitable sea to America, for the sake of liberty? What could be expected of men whose whole ancestry was cut off by the slaughter following the revocation of the Edict of Nantes, and they themselves exiled for liberty to worship God? What can be expected of men who have been tried in the furnace of temptation till they are pure gold? Nay, more, what can be expected of men who have in these temptations been strengthened out of God? Besides the strength of development by the resistance of evil, they have found that God made a way of escape, that he strengthened, them and that they were thus by supernal power able to bear it. Nay, rather, what may not be expected of such men?

But we will not forget that this great outcome is precisely the plan of God for every man’s life, and that when man works he finds that there are forces outside of him thoroughly cooperative with him. He starts a rock down the mountain side, but gravitation reaches out ready fingers and hurls it a thousand times faster and faster. He launches his ship on the sea and the wind and steam carry it thousands of miles. He speaks his quiet breath into the ear of the phone and electricity carries it in every tone and inflection of personal quality a thousand miles. He vows, and works for purity and greatness of personal character, and a thousand gravitations of love, a thousand great winds of Pentecost, a thousand vital principles on which all greatness hangs, a thousand influences of other men, and especially a thousand personal aids of a present God, cooperate with his plans and works.

Of course every man who believes in a new type so high that good birth, wealth, culture, education, and broad opportunity cannot attain it believes in the divine co-operation to that end. It must be born of the Spirit. God sends forth his Spirit into our hearts crying, Abba, Father! It pleases the Father himself to reveal his Son in us.

Not only is this cooperation true in regard to the beginning of this higher life, but especially so in regard to the development and perfection of that life into the stature of perfect manhood in Christ Jesus. By continuous effort to lead into all truth, by intensity of endeavor that can only be represented by groanings that cannot be worded in human speech, the perfection of saints is sought.

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And in the final glorification of those saints every man will say nothing of his own efforts, but all the praise will be unto him who hath redeemed us unto God, and washed us in his blood.

To what extent, then, may we expect God will lend his forces to work out our plans? First, in so far as those forces have to do with the maturing and perfecting of our character they become his plans. No energy will be withheld. All our plans should be such. The end in character may often be attained as well by failure of our plans as by success. God has to choose the poor in this world's things, rich in faith, to do his great work. And he has to make "the best laid schemes o' mice and men gang aft a-gley" to get the desired outcome of character. He is then working with, not against, us. He would rather have any star for his crown of glory than tons of perishable gold.

But outside of our plans and work for ourselves what cooperation may we expect in our plans and work for others?

Every preacher knows that for spiritual work in saving others the word of the Lord is true, "Without me ye can do nothing." There must be an outpouring of the Spirit or there is no Pentecost. Over against that settled conviction is the thrice-blessed command and assurance of the Master, "Go preach my Gospel; and lo, I am with you alway" (blessed iteration), "unto the end of the world." That has not yet come.

But there are other enterprises men must push—mines to be dug, railroads to be surveyed and built, slaves to be emancipated, farms to be cultivated, mischiefs framed by a law to be averted, charities to be exercised, schools to be founded, and generally a living to be gotten. To what extent may we expect divine aid?

First, all these things are his purposes and plans. But since it is necessary for our development that we do our level best, he will not do what we can. We can plant and water, but God only can give the increase. Even the fable maker says that a teamster, whose wagon was stuck in the mud, seeing Jupiter Omnipotens riding by on the chariot of the clouds, dropped on his knees and implored his help. "Get up, O lazy one!" said Jupiter; "clear away the mud, put your shoulder to the wheel, and whip up your horses." We may call on God to open the rock in the dry and thirsty land where no water is, but not to lift our teacups. It is no use to ask God for a special shower when deep plowing is all that is needed. It is no use to ask God to build churches, send missionaries, endow schools, and convert the world, till we have done our best.

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But when we have done our best what may we expect? All things. They shall work together for good to those who love God enough to do their best for him in any plane of work. One could preach fifty sermons on the great works done by men, obviously too great for man's accomplishment. Time would fail me to tell of Moses, Gideon, Paul, Luther, Wesley, Wilberforce, William of Orange, Washington, John Brown, Abe Lincoln, and thousands more of whom this world was not worthy, who, undeniably by divine aid, wrought righteousness. One of the great sins of our age is that men do not see God immanent in all things. We have found so many ways of his working that we call laws, so many segments of his power, that we have forgotten him who worketh all things after the counsel of his own will. A sustainer is as necessary as a creator. There are diversities of operations, but it is the same God who worketh all in all. The next great service to be done by human philosophy is to bring back God in human thought into his own world. Since these things are so, what are the conditions under which we may work the works of God by his power?

First, they must be his works, not ours as opposed to his, but ours as included in his. All our works may be wrought in God, if we do his works, follow his plans, and are aided by his strength.

Second, they must be attempted with the right motive of glorifying God. Christ is the pattern. He came not to do his own will, but the will of him who sent him. And he did always the things that pleased him. In our fervid desires for the accomplishment of some great thing we should be as willing it should be accomplished by another as by ourselves. The personal pride is often a fly in the sweet-smelling savor. God would rather have a given work not done, or done by another, than to have one of his dear ones puffed up with sinful pride. Great Saul must often be removed and the work be left undone, or be done by some humble David.

"Inaudible voices call us, and we go;
Invisible hands restrain us, and we stay;
Forces, unfelt by our dull senses, sway
Our wavering wills, and hedge us in the way
We call our own, because we do not know.

"Are we, then, slaves of ignorant circumstance?
Nay, God forbid!
God holds the world, not blind, unreasoning chance!"

How shall we secure the cooperative power? There is power of every kind everywhere in plenty. All the Niagaras and Mississippis have run to waste since they began to thunder and flow. Greater power is in the wind everywhere. One can rake up enough electricity to turn all the wheels of a great city whenever he chooses to start his rake. The sky is full of Pentecosts. Power enough, but how shall we belt on? By fasting, prayer, and by willing to do the will of God. We have so much haste that we do not tarry

at Jerusalem for fullness of power. Moses was forty years in the wilderness: Daniel fasted and prayed for one and twenty days. We are told to pray without ceasing, and that there are kinds of devils that go not out except at the command of those who fast and pray.

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"More things are wrought by prayer than
This world dreams of."

The Bible is a record of achievements impossible to man. They are achievements of leaderships, emancipations, governments, getting money for building God's houses, making strong the weak, waxing valiant in fight, and turning the world upside down. The trouble with many of our modern saints is that they seek for purity only instead of power, ecstasy instead of excellence, self-satisfaction in a garden of spices instead of a baptism that straightens them out in a garden of agony. They are seekers of spiritual joys instead of good governments, cities well policed and sewered, with every street safe for the feet of innocence. The next revelation of new possibilities of grace that will break out of the old Word will be that of power.

How will this divine aid manifest itself? In the giving of wisdom for our plans and their execution. God will not help in any foolish plans. He wants no St. Peter's built in a village of six hundred people, no temple, except on a Moriah to which a whole nation goes up. Due proportion is a law of all his creations. The disciples planned not only to begin at Jerusalem, but to stay there. Their plans were wrong, and they had to be driven out by persecutions and martyrdoms (Acts viii, 4). But Africa, Europe, and Asia eagerly received the light which Jerusalem resisted. Some ministers to-day stay by their fine Jerusalems when the kitchens of the surrounding country wait to welcome them. The Spirit suffered not Paul to go into Bithynia, but sent him to Macedonia. Had he then persisted in going to Asia his work would have been in vain.

We may expect wisdom in the choice of the human agents we select. Half a general's success lies in his choice of lieutenants. No class leader should be appointed nor steward nominated till after prayer for divine guidance. God has more efficient men for his Church than we know of. He is thinking of Paul when we see only Matthias (Acts i, 26). When Paul had to depart asunder from Barnabas God sent him Silas, the fellow-singer in the dungeon, and Timothy, who was dearer to him than any other man.

We may expect opposition to be diminished or thwarted. Let Hezekiah spread every letter of Rab-shakeh before the Lord and pray (2 Kings xix, 14). The answer will be, "I have heard" (v. 20). Let the answer to every slander that Gashmu repeateth among the heathen be, "O Lord, strengthen my hands" (Neh. vi, 9); "My God, think thou upon Tobiah and Sanballat according to these their works" (v. 14). Then all the heathen and enemies will "perceive that this work was wrought of our God" (v. l6). "When a man's ways please the Lord, he maketh even his enemies to be at peace with him." The purpose of the manifestation of the Son of God was "that he might destroy the works of the devil" (1 John iii, 8).

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Lastly, we may expect actual help. These plans are all dear to God. He wishes them all accomplished. They have been wisely made. Opposition has been diminished. It only remains that our hearts be open to guidance and strengthening. Moses was sure I AM had sent him. Elijah had the very words to be uttered to Ahab put into his mouth. Nehemiah told the people that for building a city "the joy of the Lord is your strength." God strengthened the right hand of Cyrus. The three Hebrew children and Daniel knew that God was able to deliver them from fire and lions. "Delight thyself also in the Lord, and he shall give thee the desires of thy heart." And the great promise of the Lord to be with his disciples to the end is not so much a promise for comfort as for the accomplishment of their mission. Paul said, "I can do all things through Christ which strengtheneth me." And all great doers for God, in all ages, have gladly testified that they have been girded for their work by the Almighty.

The designed outcome of this paper is that every reader should get a fresh revelation of the immanency of God in the kingdom of nature and grace; that the reader is more intimately related to him and his plans than is gravitation; that there are laws as imperative, exact, and sure to yield results in the mental and spiritual realms as in the material; that he is a part of God's agencies, and that all of God's forces are a part of his; that he may sing with new meaning,

"We for whose sakes all nature stands
And stars their courses move;"

that in the burning vividness of this new conception each man may boldly undertake things for God—conversions, purifications, missionary enlargements, business enterprises—that he knows are too great for himself; that he may find new helps for spiritual victories as great as this age has found for material triumphs in steam and electricity; and that in all things man may be uplifted and God thereby glorified.

How shall it be done?

First, by a vivid conception that cooperation is designed, provided for, and expected. We are children of God; there can be but one great end through the ages in the universe. There should be cooperation of every force. There have been thousands of evident cooperations—waters divided and burned by celestial fire, Pharaohs rebuked, Ninevehs warned, exiles recalled, Jerusalems rebuilded, Luthers upheld, preachers of today changed from waning, not desired, half-over-the-dead-line ministers into vigorous, flaming heralds of the Gospel, who possessed tenfold power to what they had before; we ourselves personally helped in manifest and undeniable instances, and so have come to believe that God can do anything, anywhere, if he can get the right kind of a man. Promises of aid are abundant. Heaven and earth shall pass away sooner than one jot or tittle of these words fail. We are invited to test them: "Come now, and prove me herewith, and see if I will not open the windows of heaven once more, as at the deluge, and pour you out a blessing that there shall not be room enough to receive it."

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Second, select some definite work too great for us to do alone, as the preparation of a sermon that shall have unusual power of persuasion to change action, the conduct of a prayer meeting of remarkable interest, the casting out of some devil of evil speech or action, the conversion of one individual, the raising of more money for some of God's purposes, and then go about the work, not alone, but in such a way that God can lead and we help. Let the fasting and prayer not be lacking. When the right direction comes let Jonathan take his armor-bearer and climb up on his hands and knees against the Philistines, let Paul go to Macedonia, Peter to Cornelius, Wesley send help to America. Bishop Foss said, in regard to several crises in a most serious sickness, that Christ always arrived before it came. So in regard to work to be done. The Lord was in Nineveh before Jonah, in Caesarea before Peter, and will be in the heart of every sinner we seek to get converted before we arrive. Any man who wants to do an immense business should seek a good partner. We are workers together with God. What is being done worthy of the copartnership?

WHEN THIS WORLD IS NOT*

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"The day of the Lord will come . . .; in which the heavens shall pass away with a great noise, and the elements shall melt with fervent heat, the earth also and the works that are therein shall be burned up."

What is there after that?

To this question there are three answers:

I. There are left all of what may be called natural forces that there were before the world was created. They are not dependent on it. The sea is not lost when one bubble or a thousand break on the rocky shore. The world is not the main thing in the universe. It is only a temporary contrivance, a mere scaffolding for a special purpose. When that purpose is fulfilled it is natural that it should pass away. The time then comes when the voice that shook the earth should signify the removal of "those things that are shaken, as of things that are made, that those things which cannot be shaken may remain." We already have a kingdom that cannot be moved. "The things which are seen are temporal; but the things which are not seen are eternal."

It should not be supposed that the space away from the world is an empty desert. God is everywhere, and creative energy is omnipresent. Not merely is a millionth of space occupied where the worlds are, but all space is full of God and his manifestations of wisdom and power. David could think of no place of hiding from that presence. The first word of revelation is, "In the beginning God created the heaven." And the great angel, standing on sea and land when time is to be no longer, swears by Him who

“created heaven, and the things that therein are,” in distinction from the earth and its things that are to be removed. What God created with things that are therein is not empty. Poets, the true seers, recognize this. When Longfellow died one of them, remembering the heartbreaking hunt of Gabriel for Evangeline, and their passing each other on opposite sides of an island in the Mississippi, makes him say of his wife long since gone before:

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And now I shall seek her once more,
  On some Mississippi's vast tide
That flows the whole universe through,
  Than earth's widest rivers more wide.

Evangeline I shall not miss
  Though we wander the dim starry sheen,
On opposite sides of rivers so vast
  That islands of worlds intervene.

But what is there in space? There is the great ceaseless force of gravitation. Though the weakest of natural forces, yet when displayed in world-masses its might is measureless by man's arithmetic. Tie an apple or a stone to one end of a string, and taking the other end whirl it around your finger, noting its pull. That depends on the weight of the whirling ball, the length of the string, and the swiftness of the whirl. The stone let loose from David's finger flies crashing into the head of Goliath. But suppose the stone is eight thousand miles in diameter, the string ninety-two million five hundred thousand miles long, and the swiftness one thousand miles a minute, what needs be the tensile strength of the string? If we covered the whole side of the earth next the sun, from pole to pole and from side to side, with steel wires attaching the earth to the sun, thus representing the tension of gravitation, the wires would need to be so many that a mouse could not run around among them.

There swings the moon above us. Its best service is not its light, though lovers prize that highly. Its gravitative work is its best. It lifts the sea and pours it into every river and fiord of the coast. Our universal tug-boat is in the sky. It saves millions of dollars in towage to London alone every year. And this world would not be habitable without the moon to wash out every festering swamp and deposit of sewage along the shore.

Gravitation reaches every place, whether worlds be there or not. This force is universally present and effective. In the possibilities of a no-world condition a spirit may be able to so relate itself to matter that gravitation would impart its incredible swiftness of transference to a soul thus temporarily relating itself to matter. What gravitation does in the absence of the kind of matter we know it is difficult to assert. But as will be seen in our second division there is still ample room for its exercise when worlds as such have ceased to be.

In space empty of worlds there is light. It flies or runs one hundred and eighty-six thousand miles a second. There must be somewhat on which its wing-beat shall fall, stepping stones for its hurrying feet. We call it ether, not knowing what we mean. But in this space is the play of intensest force and quickest activity. There are hundreds of millions of millions of wing-beats or footfalls in a second. Mathematical necessities surpass mental conceptions. In a cubic mile of space there are demonstrably seventy millions of foot tons of power. Steam and lightning have nothing comparable to the

activity and power of the celestial ether. Sir William Thompson thinks he has proved that a cubic mile of celestial ether may have as little as one billionth of a pound of ponderable matter. It is too fine for our experimentation, too strong for our measurement. We must get rid of our thumby fingers first.

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What is light doing in space? That has greatly puzzled all philosophers. Without question there is inexpressible power. It is seen in velocity. But what is it doing? The law of conservation of force forbids the thought that it can be wasted. On the earth its power long ages ago was turned into coal. The power was reservoired in mountains ready for man. It is so great that a piece of coal that weighs the same as a silver dollar carries a ton's weight a mile at sea. But what is the thousand million times more light than ever struck the earth doing in space? That is among the things we want to find out when we get there. There will be ample opportunity, space, time, and light enough.

It is biblically asserted and scientifically demonstrable that space is full of causes of sound. To anyone capable of turning these causes to effects this sound is not dull and monotonous, but richly varied into songful music. Light makes its impression of color by its different number of vibrations. So music sounds its keys. We know the number of vibrations necessary for the note C of the soprano scale, and the number that runs the pitch up to inaudibility. We know the number of vibrations of light necessary to give us a sensation of red or violet. These, apprehended by a sufficiently sensitive ear, pour not only light to one organ, but tuneful harmonies to another. The morning stars do sing together, and when worlds are gone, and heavy ears of clay laid down, we may be able to hear them

Singing as they shine,
"The hand that made us is divine."

There are places where this music is so fine that the soft and soul-like sounds of a zephyr in the pines would be like a storm in comparison, and places where the fierce intensity of light in a congeries of suns would make it seem as if all the stops of being from piccolo to sub-bass had been drawn. No angel flying interstellar spaces, no soul fallen overboard and left behind by a swift-sailing world, need fear being left in awful silences.

There seems to be good evidence that electrical disturbances in the sun are almost instantly reported and effective on the earth. It is evident that the destructive force in cyclones is not wind, but electricity. It is altogether likely that it is generated in the sun, and that all the space between it and us thrills with this unknown power.[1] All astronomers except Faye admit the connection between sun spots and the condition of the earth's magnetic elements. The parallelism between auroral and sun-spot frequency is almost perfect. That between sun spots and cyclones is as confidently asserted, but not quite so demonstrable. Enough proof exists to make this clear, that space may be full of higher Andes and Alps, rivers broader than Gulf Streams, skies brighter than the Milky Way, more beautiful than the rainbow. Occasionally some scoffer who thinks he is smart and does not know that he is mistaken

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asks with an air of a Socrates putting his last question: "You say that 'heaven is above us.' But if one dies at noon and another at midnight, one goes toward Orion and the other toward Hercules; or an Eskimo goes toward Polaris and a Patagonian toward the coal-black hole in the sky near the south pole. Where is your heaven anyhow?" O sapient, sapient questioner! Heaven is above us, you especially; but going in different directions from such a little world as this is no more than a bee's leaving different sides of a bruised pear exuding honey. Up or down he is in the same fragrant garden, warm, light, redolent of roses, tremulous with bird song, amid a thousand caves of honeysuckles, "illuminate seclusions swung in air" to which his open sesame gives entrance at will.

II. But there will be in space what the world has become. It is nowhere intimated that matter had been annihilated. Worlds shall perish as worlds. They shall wax old as doth a garment. They will be folded up as a vesture, and they "shall be changed." The motto with which this article began says heavens pass away, elements melt, earth and its works are burned up. But always after the heaven and earth pass away we are to look for "new heavens and a new earth." On all that God has made he has stamped the great principle of progress, refinement, development—rock to soil, soil to vegetable life, to insect, bird, and man. Each dies as to what it is, that it may have resurrection or may feed something higher. So, in the light of revelation, earth is not lost. Science comes, after ages of creeping, up to the same position. It, too, asserts that matter is indestructible. Burn a candle in a great jar hermetically sealed. The weight of the jar and contents is just the same after the burning as before. A burned-up candle as big as the world will not be annihilated. It will be "changed."

It is necessary for us to get familiar with some of the protean metamorphoses of matter. Up at New Almaden, above the writer, is a vast mass of porous lava rock into which has been infiltrated a great deal of mercury. How shall we get it out? You can jar out numberless minute globules by hand. This metal, be it remembered, is liquid, and so heavy that solid iron floats in it as cork does in water. Now, to get it out of the rock we apply fire, and the mercury exhales away in the smoke. The real task of scientific painstaking is to get that heavy stuff out of the smoke again. It is changed, volatilized, and it likes that state so well that it is very difficult to persuade it to come back to heaviness again.

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Take a great mass of marble. It was not always a mountain. It floated invisibly in the sea. Invisible animals took it up, particle by particle, to build a testudo, a traveling house, for themselves. The ephemeral life departing, there was a rain of dead shells to make limestone masses at the bottom of the sea. It will not always remain rock. Air and water disintegrate it once more. Little rootlets seize upon it and it goes coursing in the veins of plants. It becomes fiber to the tree, color to the rose, and fragrance to the violet. But, whether floating invisibly in the water, shell of infusoria in the seas, marble asleep in the Pentelican hills, constituting the sparkle and fizz of soda water, claiming the world's admiration as the Venus de Milo, or giving beauty and meaning to the most fitting symbol that goes between lovers, it is still the same matter. It may be diffused as gas or concentrated as a world, but it is still the same matter.

Matter is worthy of God's creation. Astronomy is awe-full; microscopy is no less so. Astronomy means immensity, bulk; atoms mean individuality. The essence of matter seems to be spirit, personality. It seems to be able to count, or at least to be cognizant of certain exact quantities. An atom of bromine will combine with one of hydrogen; one of oxygen with two of hydrogen; one of nitrogen with three of hydrogen; one of silicon with four of hydrogen, *etc*. They marry without thought of divorce. A group of atoms married by affinity is called a molecule. Two atoms of hydrogen joined to one of oxygen make water. They are like three marbles laid near together on the ground, not close together; for we well know that water does not fill all the space it occupies. We can put eight or ten similar bulks of other substances into a glass of water without greatly increasing its bulk, some actually diminishing it. Water molecules are like a mass of shot, with large interstices between. Drive the atoms of water apart by heat till the water becomes steam, till they are as three marbles a larger distance apart, yet the molecule is not destroyed, the union is still indissoluble. One physicist has declared that the atoms of oxygen and hydrogen are probably not nearer to each other in water than one hundred and fifty men would be if scattered over the surface of England—one man for each four hundred square miles.[2] What must the distance be in steam? what the greater distance in the more extreme rarefactions? It is asserted that millions of cubic miles of some comets tails would not make a cubic inch of matter solid as iron. Now, when earth and oceans are "changed" to this sort of tenuity creations will be more easy. We shall not be obliged to hew out our material with broadaxes, nor blast it out with dynamite. Let us not fear that these creations will not be permanent; they will be enough so for our purpose. We can then afford to waste more worlds in a day than dull stupidity can count in a lifetime.

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We are getting used to this sort of work already. When we reduce common air in a bulb to one one-thousandth of its normal density at the sea we get the possibility of continuous incandescent electric light by the vibration of platinum wire. When we reduce it to a tenuity of one millionth of the normal density we get the possibility of the X rays by vibrations of itself without any platinum wire. The greater the tenuity the greater the creative results. For example, water in freezing exerts an expansive, thrusting force of thirty thousand pounds to the square inch, over two thousand tons to the square foot; an incomprehensible force, but applicable in nature to little besides splitting rocks. On the other hand, when water is rarefied into steam its power is vastly more versatile, tractable, and serviceable in a thousand ways. Take a bit of metal called zinc. It is heavy, subject to gravitation, solid, subject to cohesion. But cause it to be burned, to pass away, and be changed. To do this we use fire, not the ordinary kind, but liquid that we keep in a bottle and call acid. The zinc is burned up. What becomes of it? It becomes electricity. How changed! It is no longer solid, but is a live fire that rings bells in our houses, picks up our thought and pours it into the ear of a friend miles away by the telephone, or thousands of miles away by the telegraph. Burning up is only the means of a new and higher life. Ah, delicate Ariel, tricksy sprite, the only way to get you is to burn up the solid body.

The possibility of rare creation depends on rare material, on spirit-like tenuity. And that is what the world goes into. There is a substance called nitrite of amyl, known to many as a medicine for heart disease. It is applied by inhaling its odor—a style of very much rarefied application. Fill a tube with its vapor. It is invisible as ordinary air in daylight. But pour a beam of direct sunlight from end to end along its major axis. A dense cloud forms along the path of the sunbeam; creation is going on. What the sun may do in the thinner vapors the world goes into when burned up will be for us to find out when we get there. Standing on Popocatepetl we have seen a sea of clouds below, white as the light of transfiguration, tossed into waves a mile high by the touch of the sunbeam. Creative ordering was observed in actual process. It is done under our eyes to show us how easy it is. Would it be any less glorious if there were no Popocatepetl? A thrush among vines outside is just now showing us how easy it is to create an ecstasy of music out of silence. She has only to open her mouth and the innate aptitudes of air rush in to actualize her creative wish. Not only is it easy for the bird, but she is even provoked to this love and good works by the creation of a rainbow on the retreating blackness of a storm yonder. Thunder is the sub-bass nature furnishes her, and thus invites her to add the complementary notes.

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Some one may think that all this tenuity is as vaporous as the stuff that dreams are made of, and call for solid rocks for foundations. Perhaps we may so call while we have material bodies of two hundred pounds' weight. Yet even these bodies are delicate enough to be valuable to us solely because they have the utmost chemical stability. We are burning up their substance with every breath in order to have delicacy of feeling and thought. What were a wooden body worth? Substances are valuable to us according to their fineness and facility of change. Even iron is mobile in all its particles. We call it solid, but it is not. We lift our eyes from this writing and behold the tumbling surf of the great Pacific sea. Line after line of its billows are charging on the shore and tumbling in utmost confusion and roar of advancing and refluent waves. So the iron of the telephone wire. You often hold the receiver to your ear listening, not to the voice of business or friendship of men, but to the gentle hum of the rolling surf in the wire's own substance. And, in order that we may know the essential stability of things that are fine, we are told that the city which hath enduring foundations is in the spirit world, not this kind of material. The whole new Jerusalem to come down "out of heaven, prepared as a bride adorned for her husband," is as movable as a train of cars is movable here. There may still be rainbows and rivers of life if there are no more rocks. There is a real realm of "scientific imagination." But all our imaginings fall far short of realities. Some men do not desire this realm, and demand solid rocks to walk on. But a bird does not. He oars himself along the upper fields and rides on air. So does a bicyclist and balloonist. Some men have a sort of contempt for aeronauts and workers at flying machines. That feeling is a testimony to their depravity and groveling tendencies. Aeronautics and nautics are an effort toward angelhood. Men can walk water who are willing to take a boat for an overshoe. So we may air when we get the right shoe. Browning gives us a delicious sense of being amphibian as we swim. And the butterfly, that winged rather than rooted flower, looking down upon us as we float, begets in us a great longing to be polyphibian. We have innate tendencies toward a life of finer surroundings, and we shall take to them with zest, if we are not too much of the earth earthy. We were designed for this finer life. We do take to it even now in the days of our deterioration, not to say depravity. The great marvels of the world are not so much in matter as in man. We were meant to be more sensitive to finer influences than we are. We are far more so than we think. Take your child into the street. Another child coughs at a window on the other side, and your child has three months of terrific whooping-cough. All such diseases are taken by homeopathic doses of the millionth dilution. Many people feel "in

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their bones" the coming of storms days before their arrival. We knew a man who ate honey with delight till he was twenty-five years old, and then could do so no more. This peculiarity he inherited from his father. One man has an insatiable desire for drink because some ancestor of his, back in the third or fourth generation, bequeathed him that curse. In the South you can go a mile in the face of the wind and find that peerless blossom of a magnolia by following the drift of its far-reaching odor. Who has not received a letter and knew before opening it that it had violets within? It had atmosphered itself with rich perfume, and something far richer, for three thousand miles. The first influences which came over the Atlantic cable were so feeble that a sleeping infant's breath were a whirlwind in comparison. But they were read. It is no wonder that the old astrologers thought that men's whole lives were influenced by the stars. Every vegetable life, from the meanest flower that blows to the largest tree, has its whole existence shaped by the sun. Doubtless man's body was meant to be an Aeolian (how the vowels and liquids flow into the very name!) harp of a thousand strings over which a thousand delicate influences might breathe. Soul was meant to be sensitive to the influences of the Spirit. This capability has been somewhat lost in our deterioration. To recover these finer faculties men are required to die. And for the field of exercising them the world must be changed. Paul understood this. He associated some sort of perfection with the resurrection, with the buying back of the powers of the body. And the whole creation waiteth for the apocalypse of the full-sized sons of God.

Does one fear the change from gross to fine, from force of freezing to the winged energy of steam, from solid zinc to lightning? Our whole desire for education is a desire for refining influences. We know there is a higher love for country than that begotten by the fanfare of the Fourth of July. There is a smile of joy at our country's education and purity finer than the guffaws provoked by hearing the howls of a dog and the explosions of firecrackers when the two are inextricably mixed. There is a flame of religious love when the heart sacrifices itself in humble realization of the joy of its adorable love purer than the fierce fire of the hating heart that applies the torch to the martyr's pyre. We give our lives to seeking these higher refinements because they are stronger and more like God.

Does one fear to leave bodily appetites and passions for spiritual aptitudes fitted to finer surroundings? He should not. Man has had two modes of life already—one, slightly conscious, closely confined, peculiarly nourished, in the dark, without the possible exercise of any one of the five senses. That is prenatal. He comes into the next life. At once he breathes, often vociferously, looks about with eyes of wonder, nourishes himself with avidity,

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is fitted to his new surroundings, his immensely wider life, and finds his superior companions and surroundings fitted to him, even to his finest need for love. Why hesitate for a third mode of life? He loses modes of nourishment; so he has before. He loses relations to former life; so he has before. He comes into new companionships and surroundings; so he has before. But each time and in every respect his powers, possibilities, and field have been immensely enlarged.

O the hour when this material
Shall have vanished like a cloud,
When amid the wide ethereal
All the invisible shall crowd.
In that sudden, strange transition,
By what new and finer sense
Shall we grasp the mighty vision,
And receive the influence?

Knowledge of the third state of man is not so difficult to attain in the second as knowledge of the second was in the first. If a fit intelligence should study a specimen of man about to emerge from its first stage of existence, it could judge much of the conditions of the second. Feet suggest solid land; lungs suggest liquid air; eyes, light; hands, acquisitiveness, and hence dominion; tongue, talk, and hence companions, *etc*. What fore-gleams have we of the future life? They are from two sources—revelation and present aptitudes not yet realized. What feet have we for undiscovered continents, what wings for wider and finer airs, what eyes for diviner light? Everything tells us that such aptitudes have fit field for development. The water fowl flies through night and storm, lone wandering but not lost, straight to the south with instinct for mild airs, food, and a nest among the rushes. It is not disappointed.

Man has an instinct for dominion which cannot be gratified here. He weeps for more worlds to conquer. He is only a boy yet, getting a grip on the hilt of the sword of conquest, feeling for some Prospero's wand that is able to command the tempest. When he gets the proper pitch of power, take away his body, and he is, as Richter says, no more afraid, and he is also free from the binding effect of gravitation. Then there are worlds enough, and every one a lighthouse to guide him to its harbor. They all seek a Columbus with more allurements than America did hers. Dominion over ten cities is the reward for faithfulness in the use of a single talent.

Man has an instinct for travel and speed. To travel a couple of months is a sufficient reward for a thousand toilful days. He earnestly desires speed, develops race horses and bicycles to surpass them, yachts, and engines. Not satisfied with this, he harnesses lightning that takes his mind, his thought, to the ends of the earth in a twinkling. But he is stopped there. How he yearns to go to the moon, the sun, and

stars! But he could not take his present body through the temperatures of space three or four hundred degrees below zero. So he must find a way of disembodying and of attachment to some force swift as lightning, of which there are plenty in the spaces when the world has ceased to be a world. It is all provided for by death.

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Man has an instinct for knowledge not gratified nor gratifiable in the present narrow bounds that hedge him in like walls of hewn stone. A thousand questions he cannot solve about himself, his relations to others and to the world about him, beset him here. There he shall know even as he is known by perfect intelligence.

Here he has an instinct for love that is unsunderable. But the wails of separation have filled the air since Eve shrieked over Abel. Husbands and fathers are ever crying:

> Immortal? I feel it and know it.
> Who doubts of such as she?
> But that's the pang's very essence,
> Immortal away from me.

But there, in finer realms, shall be a knitting of severed friendships up to be sundered no more forever.

Specially has man sought in this stage of being to know God. Job, in his pain and loss, assailed by the cruel rebukes of his friends and desolate by the desertion of his wife, says, "O that I knew where I might find him." David cries out while his tears are flowing day and night, "As the hart panteth after the water brooks, so panteth my soul after thee, O God. My soul thirsteth for God, for the living God: when shall I come and appear before God?" Moses, in the broadest of visions, material, historic, prophetic, says to God, "Show me thy glory." And common men have always turned the high places of earth to altar piles, and blackened the heavens with the smoke of their sacrifices. But the means of knowing God are to be increased. The very essence of life eternal is to know the true God, and Jesus Christ whom he has sent. Great pains have been taken to manifest forth God to dull senses and to oxlike thoughts here; greater pains, with better results, shall be taken there. Every reader of the Apocalypse notices with joy, if not rapture, that when the book that was sealed with seven seals, which no man in heaven, nor earth, was able to reveal, nor open, nor even look upon, was finally opened by the Lamb, and its marvelous panoramas, charades, and symbolic significances had to be carefully explained to John, the man best able of any to understand them—we observe with rapture that the regular inhabitants of that hitherto unseen world understood all at once, and broke into shouts like the sound of these many waters in a storm. Above all these superior manifestations in finer realms the pure in heart shall *see* God.

III. But there is in space what there was before the world began. Philosophy asserts that the invisible universe is a perfect fluid in which not even atoms exist, and atoms are produced therefrom by the First Great Cause by creation, not by development. This conception is full of difficulties to thought. We cannot even agree whether creation was in time or eternity. But all agree in this, that the invisible is rapidly absorbing all the force at least of the visible universe, and that when force is gone the corpse will not remain unburied. Indeed,

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when the range of seeing puts the size of an atom at less than one two-hundred-and-twenty-four-thousandth of an inch, and when the range of thinking puts it at less than one six-millionth of an inch, many prefer to consider an atom as a center of force and not as a material entity at all. But, amid uncertainties, this is certain, that the forces of the visible worlds are extraneous. They come out of the invisible. They are all also returning to the invisible; that is what light is doing in space, previously referred to. This incredibly high-class energy is not banking up coal in the celestial ether as it did on the earth, but is returning to the quick, mobile forces of the invisible worlds. One thing more is certain, that the origin of all the forces of the invisible is in personality; for the atom, it is agreed, bears all the marks of being a manufactured article. Different-sized shot could not have greater uniformity of structure and constitution. And their whole behavior shows that they are controlled by an admirable wisdom past finding out.

That these forces exist and are necessarily active there are three proofs. Worlds have been made, not of things and forces that do appear. They were abundantly displayed in the physical miracles of Christ and others; and these forces, independently of the physical miracles at various times, have continuously helped men.

(1) Concerning the first fact—that worlds have been made—nothing need be said except that these forces, being personal, cannot be supposed to be exhausted, and hence creations can go on continuously. We are assured that they do. And the personal element more and more relates itself to personalities. “I go to prepare a place for you,” to fit up a mansion according to tastes, needs, and enjoyments of the future occupant.

(2) This is the place to assert, not to prove, that this visible world has always been subject to the forces of the invisible world. It does not matter whether these forces are personal or personally directed. Its waters divide, gravitation at that point being overcome; they harden for a path, or bodies are levitated; they burn by a fire as fierce as that which plays between two electric poles. These forces are not the ordinary endowments of matter; they step out of the realm of the greater invisible, execute their mission, and, like an angel’s sudden appearance, disappear. Who knows how frequently they come? We, for whose sake all nature stands “and stars their courses move,” may need more frequent motherly attentions than the infant knows of. They will not be lacking, even if not sufficiently evident to the infant to be cried for. “Your heavenly Father knoweth that ye have need of all these things.”

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(3) It is here designed to be asserted that the forces of the invisible seek to be continually in full play on the intellectual and moral natures of man. Our unique Christian Scriptures have this thought for their whole significance. It begins with God's walking with Adam in the garden, and goes on till it is said, "Come, ye blessed of my Father, inherit the kingdom prepared for you," in the invisible, and by the invisible, from before the foundation of the visible world. It includes all time and opportunity between and after; we need specify only to intensify the conception of the fact. Paul says, "Having therefore obtained help of God, I continue unto this day," when otherwise oppressive circumstances and hate of men seeking to kill him would have prevented his continuing in life. It is possible for all who believe to be given power, out of the invisible, to become sons of God. It has been said that there is power and continuousness enough in the tides, winds, rotating and revolving worlds for man to make a machine for perpetual motion. The only difficulty is to belt on. The great object of life in the visible should be to belt on to the invisible. Our great Example who did this made his ordinary doing better than common men's best, his parentheses of thought richer than other men's paragraphs and volumes. And he left on record for us promises of greater works than these, at which we stagger through unbelief. We should not; for men who have lived by the evidence of things not seen, and sought a city that received Jesus out of sight, have found that "God is not ashamed to be called their God." They have wrought marvels that men tell over like a rosary of what is possible to men. It is beyond the belief of all who have not been touched by the power of an endless life. But what they do is chiefly valuable as evidence of what they are. It is little that men quench the violence of fire, and receive their dead raised to life again. It is great that they are able to do it. That they hold the hand that holds the world is something. But that they have eyes to see, a wisdom to choose, and will to execute the best, is more. Fire may kindle again and the resurrected die, but the great personality survives.

These forces are not discontinuous, connected with this temporary world, and liable to cease when it fails. They belong to the permanent, invisible order of things. Suppose one loses his body. Then there is no force whereby earth can hold its child any longer to its breast. It flies on at terrific speed, dwindling to a speck in unknown distances, and leaving the man amid infinitudes alone. But there are other attractions. There was One uplifted on a cross to draw all men unto him. Love has finer attraction for souls than gravitation has for bodies.

Then all his being thrills with Joy. And past
The comets' sweep, the choral stars above,
With multiplying raptures drawn more swift
He flies into the very heart of love.

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It is hoped that the object of this writing is accomplished—to widen our view of the great principle of continuity in the universe. It is not sought to dwarf the earth, but to fit it rightly into its place as a part of a great whole. It is better for a state to be a part of a glorious union than to be independent; better for a man to belong to the entirety of creation than to be Robinson Crusoe on his island. We belong to more than this earth. It is not of the greatest importance whether we lose it or it lose itself. We look for a "new heavens and a new earth." We are, or should be, used to their forces, and at home among their personalities. This universe is a unity. It is not made up of separate, catastrophic movements, but it all flows on like the sweetly blended notes of a psalm. "Therefore will not we fear, though the earth be removed, and though the mountains be carried into the midst of the sea;" though the heavens be "rolled together as a scroll," the stars fall, "even as a fig tree casteth her untimely figs," when it is shaken with the wind, and though our bodies are whelmed in the removal of things that can be shaken. For even then we may find the calm force that shakes the earth is the force that is from everlasting to everlasting; may find that it is personal and loving. It says, "Lo, it is I; be not afraid."

Whatever comes, whether one sail the spaces in the great ship we call the world, or fall overboard into Mississippis and Amazons of power in which worlds are mere drifting islands, he will be at peace and at home anywhere. He will ever say:

"The winds that o'er my ocean run
Blow from all worlds, beyond the sun;
Through life, through death, through faith, through time,
Great breaths of God, they sweep sublime,
Eternal trades that cannot veer,
And blowing, teach us how to steer;
And well for him whose joy, whose care,
Is but to keep before them fair.

"O thou, God's mariner, heart of mine,
Spread canvas to these airs divine.
Spread sail and let thy past life be
Forgotten in thy destiny."

[1]The action that drives off the material of a comet's tail proves that other forces besides gravitation are operative in the interplanetary space.—*The Sun*, C. A. Young, p. 156.

[2]See *Recreations in Astronomy*, p. 357.