RAY BAKER

BOYS' SECOND BOOK OF INVENTIONS

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Содержание

Ray Stannard Baker
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CHAPTER I
THE MIRACLE OF RADIUM

Story of the Marvels and Dangers of the New Element Discovered by Professor and Madame Curie

No substance ever discovered better deserves the term "Miracle of Science," given it by a famous English experimenter, than radium. Here is a little pinch of white powder that looks much like common table salt. It is one of many similar pinches sealed in little glass tubes and owned by Professor Curie, of Paris. If you should find one of these little tubes in the street you would think it hardly worth carrying away, and yet many a one of them could not be bought for a small fortune. For all the radium in the world to-day could be heaped on a single table-spoon; a pound of it would be worth nearly a million dollars, or more than three thousand times its weight in pure gold.

Professor and Madame Curie, who discovered radium, now possess the largest amount of any one, but there are small quantities in the hands of English and German scientists, and perhaps a dozen specimens in America, one owned by the American Museum of Natural History and several by Mr. W. J. Hammer, of New York, who was the first American to experiment with the rare and precious substance.

And perhaps it is just as well, at first, not to have too much radium, for besides being wonderful it is also dangerous. If a pound or two could be gathered in a mass it would kill every one who came within its influence. People might go up and even handle the white powder without at the moment feeling any ill-effects, but in a week or two the mysterious and dreadful radium influence would begin to take effect. Slowly the victim's skin would peel off, his body would become one great sore, he would fall blind, and finally die of paralysis and congestion of the spinal cord. Even the small quantities now in hand have severely burned the experimenters. Professor Curie himself has a number of bad scars on his hands and arms due to ulcers caused by handling radium. And Professor Becquerel, in journeying to London, carried in his waistcoat pocket a small tube of radium to be used in a lecture there. Nothing happened at the time, but about two weeks later Professor Becquerel observed that the skin under his pocket was beginning to redden and fall away, and finally a deep and painful sore formed there and remained for weeks before healing.

It is just as well, therefore, that scientists learn more about radium and how to handle and control it before too much is manufactured.

But the cost and danger of radium are only two of its least extraordinary features. Seen in the daylight radium is a commonplace white powder, but in the dark it glows like live fire, and the purer it is the more it glows. I held for a moment one of Mr. Hammer's radium tubes, and, the lights being turned off, it seemed like a live coal burning there in my hand, and yet I felt no sensation of heat. But radium really does give off heat as well as light – and gives it off continually *without losing appreciable weight*. And that is what seems to scientists a miracle. Imagine a coal which should burn day in and day out for hundreds of years, always bright, always giving off heat and light, and yet not growing any smaller, not turning to ashes. That is the almost unbelievable property of radium. Professor Curie has specimens which have thus been radiating light and heat for several years, with practically no loss of weight; and no small amount of light and heat either. Professor Curie has found that a given quantity of radium will melt its own weight of ice every hour, and continue doing so practically for ever. One of his associates has calculated that a fixed quantity of radium, after throwing out heat for 1,000,000,000 years, would have lost only one-millionth part of its bulk.

What is the reason for these extraordinary properties? Is it not "perpetual motion"? All the great scientists of the world have been trying in vain to answer these questions. Several theories have been advanced, of which I shall speak later, but none seems a satisfactory explanation. When we know more of radium perhaps we shall be better prepared to say what it really is, and we may have to unlearn many of the great principles of physics and chemistry which were seemingly settled for all time. Radium would seem, indeed, to defy the very law of the conservation of energy.

The practical mind at once sees radium in use as a new source of heat and light for mankind, a furnace that would never have to be fed or cleaned, a lamp that would glow perpetually – and the time may really come, the inventor having taken hold of the wonder that the scientist has produced, when many practical applications of the new element may be devised. At present, however, the scarcity and cost and danger of radium will keep it in the hands of the experimenter.

Another astonishing property of radium is its power of communicating some of its strange qualities to certain substances brought within its influence. Mr. Hammer kept his radium tubes for a time in a pasteboard box. This being broken, he removed the tubes and threw the pasteboard aside. Several days later, having occasion to turn off the lights in the laboratory, he found that the discarded box was glowing there in the dark. It had taken up some of the rays from the radium. Nearly everything that comes in contact with radium thus becomes "radio-active" – even the experimenter's clothes and hands, so that delicate instruments are disturbed by the invisible shine of the experimenter. Photographs can be taken with radium; it also makes the air around it a better conductor of electricity. And still more marvellous, besides being an agency for the destruction of life, as I shall show later, it can actually be used in other ways to prolong life, and the future may show many wonderful uses for it in the treatment of disease. Already, in Paris, several cases of lupus have been cured with it, and there is evidence that it will help to restore sight in certain cases of blindness. I held a tube of radium to my closed eye and was conscious of the sensation of light; the same sensation was present when the tube was held to my temple, thus showing that the radium has an effect on the optic nerve. A little blind girl in New York, who had never had the sensation of light, began to see a little after one treatment with radium, and experiments are still going on, but cautiously, for fear that injuries may result.

We now come to the fascinating story of the discovery and manufacture of radium. It has long been known that certain substances are phosphorescent; that is, under the proper conditions they glow without apparent heat. Everybody has seen "fox-fire" in the damp and decaying woods – a cold light which scientists have never been able to explain.

To M. Henri Becquerel of the French Institute is generally given the credit for having begun the real study of radio-activity, although, as in every great discovery and invention, many other scientists and practical electricians had paved the way by their investigations. In 1896 M. Becquerel was conducting some experiments with various phosphorescent substances. He exposed some salts of the metal uranium to the sunlight until they became phosphorescent, and then tried their effect upon a photographic plate.

It rained, and he put the plate away in a drawer for several days. When he developed it he was surprised to find on it a better image than sunlight would have made. And thus, by a sort of accident, he led up to the discovery of the Becquerel rays, so called.

Uranium is extracted from a metal or ore called uranite by mineralogists, and popularly known as pitch-blende. Every young college student who has studied geology or chemistry has heard of pitch-blende.

Two years after Becquerel's discovery of the radio-activity of uranium Professor Pierre Curie and Madame Curie, of Paris, made the discovery that some of the samples of pitch-blende which they had were much more powerful than any uranium that they had used.

Was there, then, something more powerful than uranium within the pitch-blende? They began to "boil down" the waste rock left at the uranium mines, and found a strange new element, related to uranium but different, to which Madame Curie gave the name polonium, after her native land, Poland.

Then they did some more boiling down, and succeeded in isolating an entirely new substance, and the most radio-active yet discovered – radium. Shortly after that Debierne discovered still another radio-active substance, to which he gave the name actinium.

Thus three new elements were added to the list of the world's substances, and the most wonderful of these is radium. In a day, almost, the Curies became famous in the scientific world, and many of the greatest investigators in the world – Lord Kelvin, Sir William Crookes, and others – took up the study of radium.

Very rarely have a man and woman worked together so perfectly as Professor Curie and his wife. Madame Curie was a Polish girl; she came to Paris to study, very poor, but possessed of rare talents. Her marriage with M. Curie was such a union as *must* have produced some fine result. Without his scientific learning and vivid imagination it is doubtful if radium would ever have been dreamed of, and without her determination and patience against detail it is likely the dream would never have been realised.

One of the chief problems to be met in finding the secrets of radium is the great difficulty and expense, in the first place, of getting any of the substance to experiment with. The Curies have had to manufacture all they themselves have used. In the first place, pitch-blende, which closely resembles iron in appearance, is not plentiful. The best of it comes from Bohemia, but it is also found in Saxony, Norway, Egypt, and in North Carolina, Colorado, and Utah. It appears in small lumps in veins of gold, silver, and mica, and sometimes in granite.

Comparatively speaking, it is easy to get uranium from pitch-blende. But to get the radium from the residues is a much more complicated task. According to Professor Curie, it is necessary to refine about 5,000 tons of uranium residues to get a kilogramme – or about 2.2 pounds – of radium.

It is hardly surprising, therefore, considering the enormous amount of raw material which must be handled, that the cost of this rare mineral should be high. It has been said that there is more gold in sea-water than radium in the earth. Professor Curie has an extensive plant at Ivry, near Paris, where the refuse dust brought from the uranium mines is treated by complicated processes, which finally yield a powder or crystals containing a small amount of radium. These crystals are sent to the laboratory of the Curies where the final delicate processes of extraction are carried on by the professor and his wife.

And, after all, pure metallic radium is not obtained. It could be obtained, and Professor Curie has actually made a very small quantity of it, but it is unstable, immediately oxidised by the air and destroyed. So it is manufactured only in the form of chloride and bromide of radium. The "strength" of radium is measured in radio-activity, in the power of emitting rays. So we hear of radium of an intensity of 45 or 7,000 or 300,000. This method of measurement is thus explained. Taking the radio-activity of uranium as the unit, as one, then a certain specimen of radium is said to be 45 or 7,000 or 300,000 times as intense, to have so many times as much radio-activity. The radium of highest intensity in this country now is 300,000, but the Curies have succeeded in producing a specimen of 1,500,000 intensity. This is so powerful and dangerous that it must be kept wrapped in lead, which has the effect of stopping some of the rays. Rock-salt is another substance which hinders the passage of the rays.

English scientists have devised a curious little instrument, called the spinthariscope, which allows one actually to *see* the emanations from radium and to realise as never before the extraordinary atomic disintegration that is going on ceaselessly in this strange metal. The spinthariscope is a small microscope that allows one to look at a tiny fragment of radium supported on a little wire over a screen.

The experiment must be made in a darkened room after the eye has gradually acquired its greatest sensitiveness to light. Looking intently through the lenses the screen appears like a heaven of flashing meteors among which stars shine forth suddenly and die away. Near the central radium speck the fire-shower is most brilliant, while toward the rim of the circle it grows fainter. And this goes on continuously as the metal throws off its rays like myriads of bursting, blazing stars. M. Curie has spoken of this vision, really contained within the area of a two-cent piece, as one of the most beautiful and impressive he ever witnessed; it was as if he had been allowed to assist at the birth of a universe. Radium emits radiations, that is, it shoots off particles of itself into space at such terrific speed that 92,500 miles a second is considered a small estimate. Yet, in spite of the fact that this waste goes on eternally and at such enormous velocity, the actual loss sustained by the radium is, as I have said, infinitesimal.

We now come to one of the most interesting phases of the whole subject of radium – that is, the influence which its strange rays have upon animal life. Mr. Cleveland Moffett, to whom I am indebted for the facts of the following experiments, recently visited M. Danysz, of the Pasteur Institute in Paris, who has made some wonderful investigations in this branch of science. M. Danysz has tried the effect of radium on mice, rabbits, guinea-pigs, and other animals, and on plants, and he found that if exposed long enough they all died, often first losing their fur and becoming blind.

But the most startling experiment performed thus far at the Pasteur Institute is one undertaken by M. Danysz, February 3, 1903, when he placed three or four dozen little larvæ that live in flour in a glass flask, where they were exposed for a few hours to the rays of radium. He placed a like number of larvæ in a control-flask, where there was no radium, and he left enough flour in each flask for the larvæ to live upon. After several weeks it was found that most of the larvæ in the radium flask had been killed, but that a few of them had escaped the destructive action of the rays by crawling away to distant corners of the flask, where they were still living. But *they were living as larvæ, not as moths*, whereas in the natural course they should have become moths long before, as was seen by the control-flask, where the larvæ had all changed into moths, and these had hatched their eggs into other larvæ, and these had produced other moths. All of which made it clear that the radium rays had arrested the development of these little worms.

More weeks passed, and still three or four of the larvæ lived, and four full months after the original exposure one larva was still alive and wriggling, while its contemporary larvæ in the other jar had long since passed away as aged moths, leaving generations of moths' eggs and larvæ to witness this miracle, for here was a larva, venerable among his kind, that had actually lived through *three times the span of life accorded to his fellows* and that still showed no sign of changing into a moth. It was very much as if a young man of twenty-one should keep the appearance of twenty-one for two hundred and fifty years!

Not less remarkable than these are some recent experiments made by M. Bohn at the biological laboratories of the Sorbonne, his conclusions being that radium may so far modify various lower forms of life as to actually produce new species of "monsters," abnormal deviations from the original type of the species. Furthermore, he has been able to accomplish with radium what Professor Loeb did with salt solutions – that is, to cause the growth of unfecundated eggs of the sea-urchin, and to advance these through several stages of their development. In other words, he has used radium *to create life* where there would have been no life but for this strange stimulation.

So much for the wonders of radium. We seem, indeed, to be on the border-land of still more wonderful discoveries. Perhaps these radium investigations will lead to some explanation of that great question in science, "What is electricity?" – and that, who can say, may solve that profounder problem, "What is life?"

At present there are two theories as to the source of energy in radium, thus stated by Professor Curie:

"Where is the source of this energy? Both Madame Curie and myself are unable to go beyond hypotheses; one of these consists in supposing the atoms of radium evolving and transforming into another simple body, and, despite the extreme slowness of that transformation, which cannot be located during a year, the amount of energy involved in that transformation is tremendous.

"The second hypothesis consists in the supposition that radium is capable of capturing and utilising some radiations of unknown nature which cross space without our knowledge."

CHAPTER II
FLYING MACHINES [1]

Santos-Dumont's Steerable Balloons

Among the inventors engaged in building flying machines the most famous, perhaps, is M. Santos-Dumont, whose thrilling adventures and noteworthy successes have given him world-wide fame. He was the first, indeed, to build a balloon that was really steerable with any degree of certainty, winning a prize of $20,000 for driving his great air-ship over a certain specified course in Paris and bringing it back to the starting-point within a specified time. Another experimenter who has had some degree of success is the German, Count Zeppelin, who guided a huge air-ship over Lake Geneva, Switzerland, in 1901.

Carl E. Myers, an American, an expert balloonist, has also built balloons of small size which he has been able to steer.

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[1] In the first "Boys' Book of Inventions," the author devoted a chapter entitled "Through the Air" to the interesting work of the inventors of flying machines who have experimented with aëroplanes; that is, soaring machines modelled after the wings of a bird. The work of Professor S. P. Langley with his marvellous Aërodrome, and that of Hiram Maxim and of Otto Lilienthal, were given especial consideration. In the present chapter attention is directed to an entirely different class of flying machines – the steerable balloons.

And mention must also be made of M. Severo, the Frenchman, whose ship, Pax, exploded in the air on its first trip, dropping the inventor and his assistant hundreds of feet downward to their death on the pavements of Paris.

It will be most interesting and instructive to consider especially the work of Santos-Dumont, for he has been not only the most successful in making actual flights of any of the inventors who have taken up this great problem of air navigation, but his adventures have been most romantic and thrilling. In five years' time he has built and operated no fewer than ten great air-ships which he has sailed in various parts of Europe and in America. He has even crowned his experiences with more than one shipwreck in the air, an adventure by the side of which an ordinary sea-wreck is tame indeed, and he has escaped with his life as a result not only of good fortune but of real daring and presence of mind in the face of danger.

For an inventor, M. Santos-Dumont is a rather extraordinary character. The typical inventor – at least so we think – is poor, starts poor at least, and has a struggle to rise. M. Santos-Dumont has always had plenty of means. The inventor is always first a dreamer, we think. M. Santos-Dumont is first a thoroughly practical man, an engineer with a good knowledge of science, to which he adds the imagination of the inventor and the keen love and daring of the sportsman and adventurer, without which his experiments could never have been carried through.

It would seem, indeed, that nature had especially equipped

M. Santos-Dumont for his work in aërial navigation. Supposing an inventor, having all the mental equipment of Santos-Dumont, the ideas, the energy, the means – supposing such a man had weighed two hundred pounds! He would have had to build a very large ship to carry his own weight, and all his problems would have been more complex, more difficult. Nature made Santos-Dumont a very small, slim, slight man, weighing hardly more than one hundred pounds, but very active and muscular. The first time I ever saw him, in Crystal Palace, London, where he was setting up one of his air-ships in a huge gallery, I thought him at first glance to be some boy, a possible spectator, who was interested in flying machines. His face, bare and shaven, looked youthful; he wore a narrow-brimmed straw hat and was dressed in the height of fashion. One would not have guessed him to be the inventor. A moment later he had his coat off and was showing his men how to put up the great fan-like rudder of the ship which loomed above us like some enormous Rugby football, and then one saw the power that was in him. Brazilian by nationality, he has a dark face, large dark eyes, an alertness of step and an energetic way of talking. His boyhood was spent on his father's extensive coffee plantation in Brazil; his later years mostly in Paris, though he has been a frequent visitor to England and America. He speaks Spanish, French, and English with equal fluency. Indeed, hearing his English one would say that he must certainly have had his training in an English-speaking country, though no one would mistake him in appearance for either English or American, for he is very much a Latin in face and form. One finds him most unpretentious, modest, speaking freely of his inventions, and yet never taking to himself any undue credit.

Santos-Dumont is still a very young man to have accomplished so much. He was born in Brazil, July 20, 1873. From his earliest boyhood he was interested in kites and dreamed of being able to fly. He says:

"I cannot say at what age I made my first kites; but I remember how my comrades used to tease me at our game of 'Pigeon flies'! All the children gather round a table, and the leader calls out: 'Pigeon flies! Hen flies! Crow flies! Bee flies!' and so on; and at each call we were supposed to raise our fingers. Sometimes, however, he would call out: 'Dog flies! Fox flies!' or some other like impossibility, to catch us. If any one should raise a finger, he was made to pay a forfeit. Now my playmates never failed to wink and smile mockingly at me when one of them called 'Man flies!' For at the word I would always lift my finger very high, as a sign of absolute conviction; and I refused with energy to pay the forfeit. The more they laughed at me, the happier I was."

Of course he read Jules Verne's stories and was carried away in imagination in that author's wonderful balloons and flying machines. He also devoured the history of aërial navigation which he found in the works of Camille Flammarion and Wilfrid de Fonvielle. He says, further:

"At an early age I was taught the principles of mechanics by my father, an engineer of the École Centrale des Arts et Manufactures of Paris. From childhood I had a passion for making calculations and inventing; and from my tenth year I was accustomed to handle the powerful and heavy machines of our factories, and drive the compound locomotives on our plantation railroads. I was constantly taken up with the desire to lighten their parts; and I dreamed of air-ships and flying machines. The fact that up to the end of the nineteenth century those who occupied themselves with aërial navigation passed for crazy, rather pleased than offended me. It is incredible and yet true that in the kingdom of the wise, to which all of us flatter ourselves we belong, it is always the fools who finish by being in the right. I had read that Montgolfière was thought a fool until the day when he stopped his insulters' mouths by launching the first spherical balloon into the heavens."

Upon going to Paris Santos-Dumont at once took up the work of making himself familiar with ballooning in all of its practical aspects. He saw that if he were ever to build an air-ship he must first know all there was to know about balloon-making, methods of filling with gas, lifting capacities, the action of balloons in the air, and all the thousand and one things connected with ordinary ballooning. And Paris has always been the centre of this information. He regards this preliminary knowledge as indispensable to every air-ship builder. He says:

"Before launching out into the construction of air-ships I took pains to make myself familiar with the handling of spherical balloons. I did not hasten, but took plenty of time. In all, I made something like thirty ascensions; at first as a passenger, then as my own captain, and at last alone. Some of these spherical balloons I rented, others I had constructed for me. Of such I have owned at least six or eight. And I do not believe that without such previous study and experience a man is capable of succeeding with an elongated balloon, whose handling is so much more delicate. Before attempting to direct an air-ship, it is necessary to have learned in an ordinary balloon the conditions of the atmospheric medium; to have become acquainted with the caprices of the wind, now caressing and now brutal, and to have gone thoroughly into the difficulties of the ballast problem, from the triple point of view of starting, of equilibrium in the air, and of landing at the end of the trip. To go up in an ordinary balloon, at least a dozen times, seems to me an indispensable preliminary for acquiring an exact notion of the requisites for the construction and handling of an elongated balloon, furnished with its motor and propeller."

His first ascent in a balloon was made in 1897, when he was 24 years old, as a passenger with M. Machuron, who had then just returned from the Arctic regions, where he had helped to start Andrée on his ill-fated voyage in search of the North Pole. He found the sensations delightful, being so pleased with the experience that he subsequently secured a small balloon of his own, in which he made several ascents. He also climbed the Alps in order to learn more of the condition of the air at high altitudes.

In 1898 he set about experimentation in the building of a real air-ship or steerable balloon. Efforts had been made in this direction by former inventors, but with small success. As far back as 1852 Henri Gifford made the first of the familiar cigar-shaped balloons, trying steam as a motive power, but he soon found that an engine strong enough to propel the balloon was too heavy for the balloon to lift. That simple failure discouraged experimenters for a long time. In 1877 Dupuy de Lome tried steering a balloon by man power, but the man was not strong enough. In 1883 another Frenchman, Tissandier, experimented with electricity, but, as his batteries had to be light enough to be taken up in the balloon, they proved effective only in helping to weigh it down to earth again. Krebs and Renard, military aëronauts, succeeded better with electricity, for they could make a small circuit with their air-ship, provided only that no air was stirring. Enthusiasts cried out that the problem was solved, but the two aëronauts themselves, as good mathematicians, figured out that they would have to have a motor eight times more powerful than their own, and that without any increase in weight, which was an impossibility at that time.

Santos-Dumont saw plainly that none of these methods would work. What then was he to try? Why, simple enough: the petroleum motor from his automobile. The recent development of the motor-vehicle had produced a light, strong, durable motor. It was Santos-Dumont's first great claim to originality that he should have applied this to the balloon. He discovered no new principles, invented nothing that could be patented. The cigar-shaped balloon had long been used, so had the petroleum motor, but he put them together. And he did very much more than that. The very essence of success in aërial navigation is to secure *light weight with great strength and power*. The inventor who can build the lightest machine, which is also strong, will, other things being equal, have the greatest success. It is to Santos-Dumont's great credit that he was able to build a very light motor, that also gave a good horse-power, and a light balloon that was also very strong. The one great source of danger in using the petroleum motor in connection with a balloon is that the sparking of the motor will set fire to the inflammable hydrogen gas with which the balloon is filled, causing a terrible explosion. This, indeed, is what is thought to have caused the mortal mishap to Severo and his balloon. But Santos-Dumont was able to surmount this and many other difficulties of construction.

The inventor finally succeeded in making a motor – remarkable at that time – which, weighing only 66 pounds, would produce 3½ horse-power. It is easy to understand why a petroleum motor is such a power-producer for its size. The greater part of its fuel is in the air itself, and the air is all around the balloon, ready for use. The aëronaut does not have to take it up with him. That proportion of his fuel that he must carry, the petroleum, is comparatively insignificant in weight. A few figures will prove interesting. Two and one-half gallons of gasoline, weighing 15 pounds, will drive a 2½ horse-power autocycle 94 miles in four hours. Santos-Dumont's balloon needs less than 5⅓ gallons for a three hours' trip. This weighs but 37 pounds, and occupies a small cigar-shaped brass reservoir near the motor of his machine. An electric battery of the same horse-power would weigh 2,695 pounds.

Santos-Dumont tested his new motor very thoroughly by attaching it to a tricycle with which he made some record runs in and around Paris. Having satisfied himself that it was thoroughly serviceable he set about making the balloon, cigar-shaped, 82 feet long.

"To keep within the limit of weight," he says, "I first gave up the network and the outer cover of the ordinary balloon. I considered this sort of second envelope, holding the first within it, to be superfluous, and even harmful, if not dangerous. To the envelope proper I attached the suspension-cords of my basket directly, by means of small wooden rods introduced into horizontal hems, sewed on both sides along the stuff of the balloon for a great part of its length. Again, in order not to pass the 66 pounds weight, including varnish, I was obliged to choose Japan silk that was extremely fine, but fairly resisting. Up to this time no one had ever thought of using this for balloons intended to carry up an aëronaut, but only for little balloons carrying light registering apparatus for investigations in the upper air.

"I gave the order for this balloon to M. Lachambre. At first he refused to take it, saying that such a thing had never been made, and that he would not be responsible for my rashness. I answered that I would not change a thing in the plan of the balloon, if I had to sew it with my own hands. At last he agreed to sew and varnish the balloon as I desired."

After repeated trials of his motor in the basket – which he suspended in his workshop – and the making of a rudder of silk he was able, in September, 1898, to attempt real flying. But, after rising successfully in the air, the weight of the machinery and his own body swung beneath the fragile balloon was so great that while descending from a considerable height the balloon suddenly sagged down in the middle and began to shut up like a portfolio.

"At that moment," he said, "I thought that all was over, the more so as the descent, which had already become rapid, could no longer be checked by any of the usual means on board, where nothing worked.

"The descent became a rapid fall. Luckily, I was falling in the neighborhood of the soft, grassy *pélouse* of the Longchamps race-course, where some big boys were flying kites. A sudden idea struck me. I cried to them to grasp the end of my 100-meter guide-rope, which had already touched the ground, and to run as fast as they could with it *against the wind*! They were bright young fellows, and they grasped the idea and the guide-rope at the same lucky instant. The effect of this help *in extremis* was immediate, and such as I had expected. By this manœuvre we lessened the velocity of the fall, and so avoided what would otherwise have been a terribly rough shaking up, to say the least.

I was saved for the first time. Thanking the brave boys, who continued to aid me to pack everything into the air-ship's basket, I finally secured a cab and took the relic back to Paris."

His life was thus saved almost miraculously; but the accident did not deter him from going forward immediately with other experiments. The next year, 1899, he built a new air-ship called Santos-Dumont II., and made an ascension with it, but it dissatisfied him and he at once began with Santos-Dumont III., with which he made the first trip around the Eiffel Tower.

He now made ready to compete for the Deutsch prize of $20,000. The winning of this prize demanded that the trip from Saint-Cloud to the Eiffel Tower, around it and back to the starting place, a distance of some eight miles, should be made in half an hour. For this purpose he finished a much larger air-ship, Santos-Dumont V., in 1901. After a trial, made on July 12, which was attended by several accidents, the inventor decided to make a start early on the following morning, July 13. As early as four o'clock he was ready, and a crowd had begun to gather in the park.

At 6.20 the great sliding doors of the balloon-house were pushed open, and the massive inflated occupant was towed out into the open space of the park. The big pointed nose of the balloon and its fish-like belly resembled a shark gliding with lazy craft from a shadow into light waters. In the basket of the car stood the coatless aëronaut, who laughed and chatted like a boy with the crowd around him.

From the very first the conditions did not show themselves favourable for the attempt. The wind was blowing at the rate of six or seven yards a second. The change of temperature from the balloon-house to the cool morning air had somewhat condensed the hydrogen gas of the balloon, so that one end flapped about in a flabby manner. Air was pumped into the air reservoir, inside the balloon, but still the desired rigidity was not attained. But, more discouraging yet, when the motor was started, its continuous explosions gave to the practised ear signs of mechanical discord.

Nevertheless, Santos-Dumont, with his sleeves rolled up, fixed himself in his basket. His eye took a careful survey of the entire air-ship lest some preliminary had been overlooked. He counted the ballast bags under his feet in the basket, he looked to the canvas pocket of loose sand at either hand, then saw to his guide-rope.

There is a very great deal to look after in managing such a ship, and it requires a calm head and a steady hand to do it.

"Near the saddle on which I sat," he writes, "were the ends of the cords and other means for controlling the different parts of the mechanism – the electric sparking of the motor, the regulation of the carburetter, the handling of the rudder, ballast, and the shifting weights (consisting of the guide-rope and bags of sand), the managing of the balloon's valves, and the emergency rope for tearing open the balloon. It may easily be gathered from this enumeration that an air-ship, even as simple as my own, is a very complex organism; and the work incumbent on the aëronaut is no sinecure."

Several friends shook his hand, among them Mr. Deutsch. The place was very still as the man holding the guide-rope awaited the signal to let go. Then the little man in the basket above them raised his hands and shouted.

At first it did not look like a race against time. The balloon rose sluggishly, and Santos-Dumont had to dump out bag after bag of sand, till finally the guide-rope was clear of the trees. All this gave him no opportunity to think of his direction, and he was drifting toward Versailles; but while yet over the Seine he pulled his rudder ropes taut. Then slowly, gracefully, the enormous spindle veered round and pointed its nose toward the Eiffel Tower. The fans spun energetically, and the air-ship settled down to business-like travelling. It marked a straight, decided line for its goal, then followed the chosen route with a considerable speed. Soon the chug-chugging of the motor could be heard no longer by the spectators, and the balloon and car grew smaller and smaller in its halo of light smoke. Those in the park saw only the screw and the rear of the balloon, like the stern of a steamer in dry dock. Before long only a dot remained against the sky. Gradually he came nearer again, almost returning to the park, but the wind drove him back across the river Seine. Suddenly the motor stopped, and the whole air-ship was seen to fall heavily toward the earth. The crowd raced away expecting to find Santos-Dumont dead and his air-ship a wreck. But they found him on his feet, with his hands in his pockets, reflectively looking up at his air-ship among the top branches of some chestnut trees in the grounds of Baron Edmund de Rothschild, Boulevard de Boulogne.

"This," he says, "was near the *hôtel* of Princesse Ysabel, Comtesse d'Eu, who sent up to me in my tree a champagne lunch, with an invitation to come and tell her the story of my trip.

"When my story was over, she said to me:

"'Your evolutions in the air made me think of the flight of our great birds of Brazil. I hope that you will succeed for the glory of our common country.'"

And an examination showed that the air-ship was practically uninjured.

So he escaped death a second time. Less than a month later he had a still more terrible mishap, best related in his own words. He says:

"And now I come to a terrible day – August 8, 1901. At 6.30 A.M., I started for the Eiffel Tower again, in the presence of the committee, duly convoked. I turned the goal at the end of nine minutes, and took my way back to Saint-Cloud; but my balloon was losing hydrogen through the automatic valves, the spring of which had been accidentally weakened; and it shrank visibly. All at once, while over the fortifications of Paris, near La Muette, the screw-propeller touched and cut the suspension-cords, which were sagging behind. I was obliged to stop the motor instantly; and at once I saw my air-ship drift straight back to the Eiffel

Tower. I had no means of avoiding the terrible danger, except to wreck myself on the roofs of the Trocadero quarter. Without hesitation I opened the manœuvre-valve, and sent my balloon downward.

"At 32 metres (106 feet) above the ground, and with the noise of an explosion, it struck the roof of the Trocadero Hotels. The balloon-envelope was torn to rags, and fell into the courtyard of the hotels, while I remained hanging 15 metres (50 feet) above the ground in my wicker basket, which had been turned almost over, but was supported by the keel. The keel of the Santos-Dumont V. saved my life that day.

"After some minutes a rope was thrown down to me; and, helping myself with feet and hands up the wall (the few narrow windows of which were grated like those of a prison), I was hauled up to the roof. The firemen from Passy had watched the fall of the air-ship from their observatory. They, too, hastened to the rescue. It was impossible to disengage the remains of the balloon-envelope and suspension apparatus except in strips and pieces.

"My escape was narrow; but it was not from the particular danger always present to my mind during this period of my experiments. The position of the Eiffel Tower as a central landmark, visible to everybody from considerable distances, makes it a unique winning-post for an aërial race. Yet this does not alter the other fact that the feat of rounding the Eiffel Tower possesses a unique element of danger. What I feared when on the ground – I had no time to fear while in the air – was that, by some mistake of steering, or by the influence of some side-wind, I might be dashed against the Tower. The impact would burst my balloon, and I should fall to the ground like a stone. Though I never seek to fly at a great height – on the contrary, I hold the record for low altitude in a free balloon – in passing over Paris I must necessarily move above all its chimney-pots and steeples. The Eiffel Tower was my one danger – yet it was my winning-post!

"But in the air I have no time to fear. I have always kept a cool head. Alone in the air-ship, I am always very busy. I must not let go the rudder for a single instant. Then there is the strong joy of commanding. What does it feel like to sail in a dirigible balloon? While the wind was carrying me back to the Eiffel Tower I realised that I might be killed; but I did not feel fear. I was in no personal inconvenience. I knew my resources. I was excessively occupied. I have felt fear while in the air, yes, miserable fear joined to pain; but never in a dirigible balloon."

Even this did not daunt him. That very night he ordered a new air-ship, Santos-Dumont VI., and it was ready in twenty-two days. The new balloon had the shape of an elongated ellipsoid, 32 metres (105 feet) on its great axis, and 6 metres (20 feet) on its short axis, terminated fore and aft by cones. Its capacity was 605 cubic metres (21,362 cubic feet), giving it a lifting power of 620 kilos (1,362 pounds). Of this, 1,100 pounds were represented by keel, machinery, and his own weight, leaving a net lifting-power of 120 kilos (261 pounds).

On October 19, 1901, he made another attempt to round the Eiffel Tower, and was at last successful in winning the $20,000 prize. Following this great feat, Santos-Dumont continued his experiments at Monte Carlo, where he was wrecked over the Mediterranean Sea and escaped only by presence of mind, and he is still continuing his work.

The future of the dirigible balloon is open to debate. Santos-Dumont himself does not think there is much likelihood that it will ever have much commercial use. A balloon to carry many passengers would have to be so enormous that it could not support the machinery necessary to propel it, especially against a strong wind. But he does believe that the steerable balloon will have great importance in war time. He says:

"I have often been asked what present utility is to be expected of the dirigible balloon when it becomes thoroughly practicable. I have never pretended that its commercial possibilities could go far. The question of the air-ship in war, however, is otherwise. Mr. Hiram Maxim has declared that a flying machine in South Africa would have been worth four times its weight in gold. Henri Rochefort has said: 'The day when it is established that a man can direct an air-ship in a given direction and cause it to manœuvre as he wills … there will remain little for the nations to do but to lay down their arms.'"

But such experiments as Santos-Dumont's, whether they result immediately in producing an air-ship of practical utility in commerce or not, have great value for the facts which they are establishing as to the possibility of balloons, of motors, of light construction, of air currents, and moreover they add to the world's sum total of experiences a fine, clean sport in which men of daring and scientific knowledge show what men can do.

CHAPTER III
THE EARTHQUAKE MEASURER

Professor John Milne's Seismograph

Of all strange inventions, the earthquake recorder is certainly one of the most remarkable and interesting. A terrible earthquake shakes down cities in Japan, and sixteen minutes later the professor of earthquakes, in his quiet little observatory in England, measures its extent – almost, indeed, takes a picture of it. Actual waves, not unlike the waves of the sea blown up by a hurricane, have travelled through or around half the earth in this brief time; vast mountain ranges, cities, plains, and oceans have been heaved to their crests and then allowed to sink back again into their former positions. And some of these earthquake waves which sweep over the solid earth are three feet high, so that the whole of New York, perhaps, rises bodily to that height and then slides over the crest like a skiff on an ocean swell.

At first glance this seems almost too strange and wonderful to believe, and yet this is only the beginning of the wonders which the earthquake camera – or the seismograph (earthquake writer, as the scientists call it) – has been disclosing.

The earthquake professor who has worked such scientific magic is John Milne. He lives in a quaint old house in the little Isle of Wight, not far from Osborne Castle, where Queen Victoria made her home part of the year. Not long ago he was a resident of Japan and professor of seismology (the science of earthquakes) at the University of Tokio, where he made his first discoveries about earthquakes, and invented marvellously delicate machines for measuring and photographing them thousands of miles away. Professor Milne is an Englishman by birth, but, like many another of his countrymen, he has visited some of the strangest nooks and corners of the earth. He has looked for coal in Newfoundland; he has crossed the rugged hills of Iceland; he has been up and down the length of the United States; he has hunted wild pigs in Borneo; and he has been in India and China and a hundred other out-of-the-way places, to say nothing of measuring earthquakes in Japan. Professor Milne laid the foundation of his unusual career in a thorough education at King's College, London, and at the School of Mines. By fortunate chance, soon after his graduation, he met Cyrus Field, the famous American, to whom the world owes the beginnings of its present ocean cable system. He was then just twenty-one, young and raw, but plucky. He thought he was prepared for anything the world might bring him; but when Field asked him one Friday if he could sail for Newfoundland the next Tuesday, he was so taken with astonishment that he hesitated, whereupon Field leaned forward and looked at him in a way that Milne has never forgotten.

"My young friend, I suppose you have read that the world was made in six days. Now, do you mean to tell me that, if this whole world was made in six days, you can't get together the few things you need in four?"

And Milne sailed the next Tuesday to begin his lifework among the rough hills of Newfoundland. Then came an offer from the Japanese Government, and he went to the land of earthquakes, little dreaming that he would one day be the greatest authority in the world on the subject of seismic disturbances. His first experiments – and they were made as a pastime rather than a serious undertaking – were curiously simple. He set up rows of pins in a certain way, so that in falling they would give some indication as to the wave movements in the earth. He also made pendulums made of strings with weights tied at the end, and from his discoveries made with these elementary instruments, he planned earthquake-proof houses, and showed the engineers of Japan how to build bridges which would not fall down when they were shaken. So highly was his work regarded that the Japanese made him an earthquake professor at Tokio and supplied him with the means for making more extended experiments. And presently we find him producing artificial earthquakes by the score. He buried dynamite deep in the ground and exploded it by means of an electric button. The miniature earthquake thus produced was carefully measured with curious instruments of Professor Milne's invention. At first one earthquake was enough at any one time, but as the experiments continued, Professor Milne sometimes had five or six earthquakes all quaking together; and once so interested did he become that he forgot all about the destructive nature of earthquakes, and ventured too near. A ton or more of earth came crashing down around him, half burying him and smashing his instruments flat. All this made the Japanese rub their eyes with astonishment, and by and by the Emperor heard of it. Of course he was deeply interested in earthquakes, because there was no telling when one might come along and shake down his palace over his head. So he sent for Professor Milne, and, after assuring himself that these experimental earthquakes really had no serious intentions, he commanded that one be produced on the spot. So Professor Milne laid out a number of toy towns and villages and hills in the palace yard with a tremendous toy earthquake underneath. The Emperor and his gayly dressed followers stood well off to one side, and when Professor Milne gave the word the Emperor solemnly pressed a button, and watched with the greatest delight the curious way in which the toy cities were quaked to earth. And after that, this surprising Englishman, who could make earthquakes as easily as a Japanese makes a lacquered basket, was held in high esteem in Japan, and for more than twenty years he studied earthquakes and invented machines for recording them. Then he returned to his home in England, where he is at work establishing earthquake stations in various parts of the world, by means of which he expects to reduce earthquake measurement to an exact science, an accomplishment which will have the greatest practical value to the commercial interests of the world, as I shall soon explain.

But first for a glimpse at the curious earthquake measurer itself. To begin with, there are two kinds of instruments – one to measure near-by disturbances, and the second to measure waves which come from great distances. The former instrument was used by Professor Milne in Japan, where earthquakes are frequent; the latter is used in England. The technical name for the machine which measures distant disturbances is the horizontal pendulum seismograph, and, like most wonderful inventions, it is exceedingly simple in principle, yet doing its work with marvellous delicacy and accuracy.

In brief, the central feature of the seismograph is a very finely poised pendulum, which is jarred by the slightest disturbance of the earth, the end of it being so arranged that a photograph is taken of every quiver. Set a pendulum clock on the dining-table, jar the table, and the pendulum will swing, indicating exactly with what force you have disturbed the table. In exactly the same way the delicate pendulum of the earthquake measurer indicates the shaking of the earth.

The accompanying diagram gives a very clear idea of the arrangement of the apparatus. The "boom" is the pendulum. It is customary to think of a pendulum as hanging down like that of a clock, but this is a horizontal pendulum. Professor Milne has built a very solid masonry column, reaching deep into the earth, and so firmly placed that nothing but a tremor of the hard earth itself will disturb it. Upon this is perched a firm metal stand, from the top of which the boom or pendulum, about thirty inches long, is swung by means of a "tie" or stay. The end of the boom rests against a fine, sharp pivot of steel (as shown in the little diagram to the right), so that it will swing back and forth without the least friction. The sensitive end of the pendulum, where all the quakings and quiverings are shown most distinctly, rests exactly over a narrow roll of photographic film, which is constantly turned by clockwork, and above this, on an outside stand, there is a little lamp which is kept burning night and day, year in and year out. The light from this lamp is reflected downward by means of a mirror through a little slit in the metal case which covers the entire apparatus. Of course this light affects the sensitive film, and takes a continuous photograph of the end of the boom. If the boom remains perfectly still, the picture will be merely a straight line, as shown at the extreme right and left ends of the earthquake picture on this page. But if an earthquake wave comes along and sets the boom to quivering, the picture becomes at once blurred and full of little loops and indentations, slight at first, but becoming more violent as the greater waves arrive, and then gradually subsiding. In the picture of the Borneo earthquake of September 20, 1897, taken by Professor Milne in his English laboratory, it will be seen that the quakings were so severe at the height of the disturbance that nothing is left in the photograph but a blur. On the edge of the picture can be seen the markings of the hours, 7.30, 8.30, and 9.30. Usually this time is marked automatically on the film by means of the long hand of a watch which crosses the slit beneath the mirror (as shown in the lower diagram with figure 3). The Borneo earthquake waves lasted in England, as will be seen, two hours fifty-six minutes and fifteen seconds, with about forty minutes of what are known as preliminary tremors. Professor Milne removes the film from his seismograph once a week – a strip about twenty-six feet long – develops it, and studies the photographs for earthquake signs.

Besides this very sensitive photographic seismograph Professor Milne has a simpler machine, not covered up and without lamp or mirror. In this instrument a fine silver needle at the end of the boom makes a steady mark on a band of smoked paper, which is kept turning under it by means of clockwork. A glance at this smoked-paper record will tell instantly at any time of day or night whether the earth is behaving itself. If the white line on the dark paper shows disturbances, Professor Milne at once examines his more sensitive photographic record for the details.

Конец ознакомительного фрагмента.