# The Romance of Modern Invention By Archibald Williams

*The Sun-Motor used on the Pasadena Ostrich-farm, California. It works a pump capable of delivering 1,400 gallons per minute.*

[*See pp. 210, 211*.]

# THE ROMANCE OF MODERN INVENTION

CONTAINING INTERESTING DESCRIPTIONS IN NON-TECHNICAL LANGUAGE OF WIRELESS TELEGRAPHY, LIQUID AIR, MODERN ARTILLERY, SUBMARINES, DIRIGIBLE TORPEDOES, SOLAR MOTORS, AIRSHIPS, *&c. &c.*

**BY ARCHIBALD WILLIAMS AUTHOR OF "THE ROMANCE**

**OF MODERN MECHANISM” “THE ROMANCE OF MODERN ENGINEERING” *&c. &c.***

WITH TWENTY-FIVE ILLUSTRATIONS

**LONDON SEELEY AND CO. LIMITED 38 GREAT RUSSELL STREET 1907**

# Preface

The object of this book is to set before young people in a bright and interesting way, and without the use of technical language, accounts of some of the latest phases of modern invention; and also to introduce them to recent discoveries of which the full development is yet to be witnessed.

The author gratefully acknowledges the help given him as regards both literary matter and illustrations by:—Mr. Cuthbert Hall (the Marconi Wireless Telegraphy Co.); Mr. William Sugg; Mr. Hans Knudsen; Mr. F. C. B. Cole; Mr. E. J. Ryves; Mr. Anton Pollak; the Telautograph Co.; the Parsons Steam Turbine Co.; the Monotype Co.; the Biograph Co.; the Locomobile Co.; the Speedwell Motor Co.

*September 1902.*

# Contents

# List of Illustrations

# WIRELESS TELEGRAPHY

One day in 1845 a man named Tawell, dressed as a Quaker, stepped into a train at Slough Station on the Great Western Railway, and travelled to London. When he arrived in London the innocent-looking Quaker was arrested, much to his amazement and dismay, on the charge of having committed a foul murder in the neighbourhood of Slough. The news of the murder and a description of the murderer had been telegraphed from that place to Paddington, where a detective met the train and shadowed the miscreant until a convenient opportunity for arresting him occurred. Tawell was tried, condemned, and hung, and the public for the first time generally realised the power for good dormant in the as yet little developed electric telegraph.

Thirteen years later two vessels met in mid-Atlantic laden with cables which they joined and paid out in opposite directions, till Ireland and Newfoundland were reached. The first electric message passed on



August 7th of that year from the New World to the Old. The telegraph had now become a world-power.

The third epoch-making event in its history is of recent date. On December 12, 1901, Guglielmo Marconi, a young Italian, famous all over the world when but twenty-two years old, suddenly sprang into yet greater fame. At Hospital Point, Newfoundland, he heard by means of a kite, a long wire, a delicate tube full of tiny particles of metal, and a telephone ear-piece, signals transmitted from far-off Cornwall by his colleagues. No wires connected Poldhu, the Cornish station, and Hospital Point. The three short dot signals, which in the Morse code signify the letter S, had been borne from place to place by the limitless, mysterious ether, that strange substance of which we now hear so much, of which wise men declare we know so little.

Marconi's great achievement, which was of immense importance, naturally astonished the world. Of course, there were not wanting those who discredited the report. Others, on the contrary, were seized with panic and showed their readiness to believe that the Atlantic had been spanned aërially, by selling off their shares in cable companies. To use the language of the money-market, there was a temporary "slump" in cable shares. The world again woke up—this time to the fact that experiments of which it had heard faintly had at last culminated in a great triumph, marvellous in itself, and yet probably



nothing in comparison with the revolution in the transmission of news that it heralded.

The subject of Wireless Telegraphy is so wide that to treat it fully in the compass of a single chapter is impossible. At the same time it would be equally impossible to pass it over in a book written with the object of presenting to the reader the latest developments of scientific research. Indeed, the attention that it has justly attracted entitle it, not merely to a place, but to a leading place; and for this reason these first pages will be devoted to a short account of the history and theory of Wireless Telegraphy, with some mention of the different systems by which signals have been sent through space.

On casting about for a point at which to begin, the writer is tempted to attack the great topic of the ether, to which experimenters in many branches of science are now devoting more and more attention, hoping to find in it an explanation of and connection between many phenomena which at present are of uncertain origin.

What is Ether? In the first place, its very existence is merely assumed, like that of the atom and the molecule. Nobody can say that he has actually seen or had any experience of it. The assumption that there is such a thing is justified only in so far as that assumption explains and reconciles phenomena of which we have experience, and enables us to form theories which can be scientifically demonstrated correct. What scientists now say is this: that everything



which we see and touch, the air, the infinity of space itself, is permeated by a *something*, so subtle that, no matter how continuous a thing may seem, it is but a concourse of atoms separated by this something, the Ether. Reasoning drove them to this conclusion.

It is obvious that an effect cannot come out of nothing. Put a clock under a bell-glass and you hear the ticking. Pump out the air and the ticking becomes inaudible. What is now not in the glass that was there before? The air. Reason, therefore, obliges us to conclude that air is the means whereby the ticking is audible to us. No air, no sound. Next, put a lighted candle on the further side of the exhausted bell-glass. We can see it clearly enough. The absence of air does not affect light. But can we believe that there is an absolute gap between us and the light? No! It is far easier to believe that the bell-glass is as full as the outside atmosphere of the something that communicates the sensation of light from the candle to the eye. Again, suppose we measure a bar of iron very carefully while cold and then heat it. We shall find that it has expanded a little. The iron atoms, we say, have become more energetic than before, repel each other and stand further apart.

What then is in the intervening spaces? Not air, which cannot be forced through iron whether hot or cold. No! the ether: which passes easily through crevices so small as to bar the way to the atoms of air.

***A Corner of M. Marconi’s cabin on board S.S. “Minneapolis,” showing instruments used in Wireless Telegraphy.***



Once more, suppose that to one end of our iron bar we apply the negative “pole” of an electric battery, and to the other end the positive pole. We see that a current passes through the bar, whether hot or cold, which implies that it jumps across all the ether gaps, or rather is conveyed by them from one atom to another.

The conclusion then is that ether is not merely omnipresent, penetrating all things, but the medium whereby heat, light, electricity, perhaps even thought itself, are transmitted from one point to another.

In what manner is the transmission effected? We cannot imagine the ether behaving in a way void of all system.

The answer is, by a wave motion. The ether must be regarded as a very elastic solid. The agitation of a portion of it by what we call heat, light, or electricity, sets in motion adjoining particles, until they are moving from side to side, but not forwards; the resultant movement resembling that of a snake tethered by the tail.

These ether waves vary immensely in length. Their qualities and effects upon our bodies or sensitive instruments depend upon their length. By means of ingenious apparatus the lengths of various waves have been measured. When the waves number 500 billion per second, and are but the 40,000th of an inch long they affect our eyes and are named light—red light. At double the number and half the length, they give us the sensation of violet light.



When the number increases and the waves shorten further, our bodies are "blind" to them; we have no sense to detect their presence. Similarly, a slower vibration than that of red light is imperceptible until we reach the comparatively slow pace of 100 vibrations per second, when we become aware of heat.

Ether waves may be compared to the notes on a piano, of which we are acquainted with some octaves only. The gaps, the unknown octaves, are being discovered slowly but surely. Thus, for example, the famous X-rays have been assigned to the topmost octave; electric waves to the notes between light and heat. Forty years ago Professor Clerk Maxwell suggested that light and electricity were very closely connected, probably differing only in their wave-length. His theory has been justified by subsequent research. The velocity of light (185,000 miles per second) and that of electric currents have been proved identical. Hertz, a professor in the university of Bonn, also showed (1887-1889) that the phenomena of light—reflection, refraction, and concentration of rays—can be repeated with electric currents.

We therefore take the word of scientists that the origin of the phenomena called light and electricity is the same—vibration of ether. It at once occurs to the reader that their behaviour is so different that they might as well be considered of altogether different natures.

For instance, interpose the very thinnest sheet of metal between a candle and the eye, and the light is



cut off. But the sheet will very readily convey electricity. On the contrary, glass, a substance that repels electricity, is transparent, *i.e.* gives passage to light. And again, electricity can be conveyed round as many corners as you please, whereas light will travel in straight lines only.

To clear away our doubts we have only to take the lighted candle and again hold up the metal screen. Light does not pass through, but heat does. Substitute for the metal a very thin tank filled with a solution of alum, and then light passes, but heat is cut off. So that heat and electricity *both* penetrate what is impenetrable to light; while light forces a passage securely barred against both electricity and heat. And we must remember that open space conveys all alike from the sun to the earth.

On meeting what we call solid matter, ether waves are influenced, not because ether is wanting in the solid matter, but because the presence of something else than ether affects the intervening ether itself. Consequently glass, to take an instance, so affects ether that a very rapid succession of waves (light) are able to continue their way through its interstices, whereas long electric waves are so hampered that they die out altogether. Metal on the other hand welcomes slow vibrations (*i.e.* long waves), but speedily kills the rapid shakes of light. In other words, *transparency* is not confined to light alone. All bodies are transparent to some variety of rays, and many bodies to several varieties. It may perhaps even be proved



that there is no such thing as absolute resistance, and that our inability to detect penetration is due to lack of sufficiently delicate instruments.

The cardinal points to be remembered are these:—

That the ether is a universal medium, conveying all kinds and forms of energy.

That these forms of energy differ only in their rates of vibration.

That the rate of vibration determines what power of penetration the waves shall have through any given substance.

Now, it is generally true that whereas matter of any kind offers resistance to light—that is, is not so perfect a conductor as the ether—many substances, especially metals, are more sensitive than ether to heat and electricity. How quickly a spoon inserted into a hot cup of tea becomes uncomfortably hot, though the hand can be held very close to the liquid without feeling more than a gentle warmth. And we all have noticed that the very least air-gap in an electric circuit effectively breaks a current capable of traversing miles of wire. If the current is so intense that it insists on passing the gap, it leaps across with a report, making a spark that is at once intensely bright and hot. Metal wires are to electricity what speaking tubes are to sound; they are as it were electrical tubes through the air and ether. But just as a person listening outside a speaking tube might faintly hear the sounds passing through it, so an instrument gifted with an "electric ear" would detect the currents passing



through the wire. Wireless telegraphy is possible because mankind has discovered instruments which act as *electric ears or eyes*, catching and recording vibrations that had hitherto remained undetected.

The earliest known form of wireless telegraphy is transmission of messages by light. A man on a hill lights a lamp or a fire. This represents his instrument for agitating the ether into waves, which proceed straight ahead with incredible velocity until they reach the receiver, the eye of a man watching at a point from which the light is visible.

Then came electric telegraphy.

At first a complete circuit (two wires) was used. But in 1838 it was discovered that if instead of two wires only one was used, the other being replaced by an earth connection, not only was the effect equally powerful, but even double of what it was with the metallic circuit.

Thus the first step had been taken towards wireless electrical telegraphy.

The second was, of course, to abolish the other wire.

This was first effected by Professor Morse, who, in 1842, sent signals across the Susquehanna River without metallic connections of any sort. Along each bank of the river was stretched a wire three times as long as the river was broad. In the one wire a battery and transmitter were inserted, in the other a receiving instrument or galvanometer. Each wire terminated at each end in a large copper plate sunk in the water. Morse's conclusions were that provided



the wires were long enough and the plates large enough messages could be transmitted for an indefinite distance; the current passing from plate to plate, though a large portion of it would be lost in the water.[1]

[1] It is here proper to observe that the term *wireless* telegraphy, as applied to electrical systems, is misleading, since it implies the absence of wires; whereas in all systems wires are used. But since it is generally understood that by wireless telegraphy is meant telegraphy without *metal connections*, and because the more improved methods lessen more and more the amount of wire used, the phrase has been allowed to stand.

About the same date a Scotchman, James Bowman Lindsay of Dundee, a man as rich in intellectual attainments as he was pecuniarily poor, sent signals in a similar manner across the River Tay. In September, 1859, Lindsay read a paper before the British Association at Dundee, in which he maintained that his experiments and calculations assured him that by running wires along the coasts of America and Great Britain, by using a battery having an acting surface of 130 square feet and immersed sheets of 3000 square feet, and a coil weighing 300 lbs., he could send messages from Britain to America. Want of money prevented the poor scholar of Dundee from carrying out his experiments on a large enough scale to obtain public support. He died in 1862, leaving behind him the reputation of a man who in the face of the greatest difficulties made extraordinary electrical discoveries at the cost of unceasing labour; and this in spite of the fact that he had undertaken and partly executed a gigantic dictionary in fifty different languages!

***M. Marconi's Travelling Station for Wireless Telegraphy.***



The transmission of electrical signals through matter, metal, earth, or water, is effected by *conduction*, or the *leading* of the currents in a circuit. When we come to deal with aërial transmission, *i.e.* where one or both wires are replaced by the ether, then two methods are possible, those of *induction* and Hertzian waves.

To take the induction method first. Whenever a current is sent through a wire magnetism is set up in the ether surrounding the wire, which becomes the core of a "magnetic field." The magnetic waves extend for an indefinite distance on all sides, and on meeting a wire *parallel* to the electrified wire *induce* in it a *dynamical* current similar to that which caused them. Wherever electricity is present there is magnetism also, and *vice versâ*. Electricity—produces magnetism—produces electricity. The invention of the Bell telephone enabled telegraphers to take advantage of this law.

In 1885 Sir William Preece, now consulting electrical engineer to the General Post-Office, erected near Newcastle two insulated squares of wire, each side 440 yards long. The squares were horizontal, parallel, and a quarter of a mile apart. On currents being sent through the one, currents were detected in the other by means of a telephone, which remained active even when the squares were separated by 1000 yards. Sir William Preece thus demonstrated that signals could be sent without even an earth connection, *i.e.* entirely through the ether. In 1886 he sent signals between



two parallel telegraph wires 4-1/2 miles apart. And in 1892 established a regular communication between Flatholm, an island fort in the Bristol Channel, and Lavernock, a point on the Welsh coast 3-1/3 miles distant.

The inductive method might have attained to greater successes had not a formidable rival appeared in the Hertzian waves.

In 1887 Professor Hertz discovered that if the discharge from a Leyden jar were passed through wires containing an air-gap across which the discharge had to pass, sparks would also pass across a gap in an almost complete circle or square of wire held at some distance from the jar. This "electric eye," or detector, could have its gap so regulated by means of a screw that at a certain width its effect would be most pronounced, under which condition the detector, or receiver, was "in tune" with the exciter, or transmitter. Hertz thus established three great facts, that—

(*a*) A discharge of static (*i.e.* collected) electricity across an air-gap produced strong electric waves in the ether on all sides.

(*b*) That these waves could be *caught*.

(*c*) That under certain conditions the catcher worked most effectively.

Out of these three discoveries has sprung the latest phase of wireless telegraphy, as exploited by Signor Marconi. He, in common with Professors Branly of Paris, Popoff of Cronstadt, and Slaby of Charlottenburg, besides many others, have devoted their attention



to the production of improved means of sending and receiving the Hertzian waves. Their experiments have shown that two things are required in wireless telegraphy—

(i.) That the waves shall have great penetrating power, so as to pierce any obstacle.

(ii.) That they shall retain their energy, so that a *maximum* of their original force shall reach the receiver.

The first condition is fulfilled best by waves of great length; the second by those which, like light, are of greatest frequency. For best telegraphic results a compromise must be effected between these extremes, neither the thousand-mile long waves of an alternating dynamo nor the light waves of many thousands to an inch being of use. The Hertzian waves are estimated to be 230,000,000 per second; at which rate they would be 1-1/2 yards long. They vary considerably, however, on both sides of this rate and dimension.

Marconi's transmitter consists of three parts—a battery; an induction coil, terminating in a pair of brass balls, one on each side of the air-gap; and a Morse transmitting-key. Upon the key being depressed, a current from the battery passes through the coil and accumulates electricity on the brass balls until its tension causes it to leap from one to the other many millions of times in what is called a spark. The longer the air-gap the greater must be the accumulation before the leap takes place, and the greater the power of the vibrations set up. Marconi found that by connecting a kite or balloon covered with tinfoil by an aluminium wire with one of the balls, the effect of the waves was greatly increased. Sometimes he replaced the kite or balloon by a conductor placed on poles two or three hundred feet high, or by the mast of a ship.

We now turn to the receiver.

In 1879 Professor D. E. Hughes observed that a microphone, in connection with a telephone, produced sounds in the latter even when the microphone was at a distance of several feet from coils through which a current was passing. A microphone, it may be explained, is in its simplest form a loose connection in an electric circuit, which causes the current to flow in fits and starts at very frequent intervals. He discovered that a metal microphone stuck, or cohered, after a wave had influenced it, but that a carbon microphone was self-restoring, *i.e.* regained its former position of loose contact as soon as a wave effect had ceased.

In 1891 Professor Branly of Paris produced a "coherer," which was nothing more than a microphone under another name. Five years later Marconi somewhat altered Branly's contrivance, and took out a patent for a coherer of his own.

It is a tiny glass tube, about two inches long and a tenth of an inch in diameter inside. A wire enters it at each end, the wires terminating in two silver plugs fitting the bore of the tube. A space of 1/32 inch



is left between the plugs, and this space is filled with special filings, a mixture of 96 parts of nickel to 4 of silver, and the merest trace of mercury. The tube is exhausted of almost all its air before being sealed.

This little gap filled with filings is, except when struck by an electric wave, to all practical purposes a non-conductor of electricity. The metal particles touch each other so lightly that they offer great resistance to a current.

But when a Hertzian wave flying through the ether strikes the coherer, the particles suddenly press hard on one another, and make a bridge through which a current can pass. The current works a “relay,” or circuit through which a stronger current passes, opening and closing it as often as the coherer is influenced by a wave. The relay actuates a tapper that gently taps the tube after each wave-influence, causing the particles to *de*cohere in readiness for the succeeding wave, and also a Morse instrument for recording words in dots and dashes on a long paper tape.

The coherer may be said to resemble an engine-driver, and the “relay” an engine. The driver is not sufficiently strong to himself move a train, but he has strength enough to turn on steam and make the engine do the work. The coherer is not suitable for use with currents of the intensity required to move a Morse recorder, but it easily switches a powerful current into another circuit.

Want of space forbids a detailed account of Marconi’s successes with his improved instruments, but



the appended list will serve to show how he gradually increased the distance over which he sent signals through space.

In 1896 he came to England. That year he signalled from a room in the General Post-Office to a station on the roof 100 yards distant. Shortly afterwards he covered 2 miles on Salisbury Plain.

In May, 1897, he sent signals from Lavernock Point to Flatholm, 3-1/3 miles. This success occurred at a critical time, for Sir W. Preece had already, as we have seen, bridged the same gap by his