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AIRSHIP OR AEROPLANE—WHICH

The quest for a successful means of aerial navigation has been prosecuted along two different lines, according as the inventor aimed at the construction of a navigable balloon or airship, or a flying machine or aeroplane. The early flying machines, in which suspension and forward motion were attempted by imitating the flapping wings of a bird, were futile and wofully fatal. In later years they have given place to the scientifically conceived soaring machine and motor-driven aeroplane. On the other hand, the old pear-shaped balloon, which depends entirely upon the wind for propulsion, has developed into the modern, cylindrical, screw-propelled airship. The progress of invention in aeronautics has been marked, sometimes by a preference for the aeroplane, sometimes for the airship type. To-day, it must be confessed, the latter is most in the public eye, chiefly because of the stupendous proportions of the Zeppelin airship, now nearing completion on its floating dock in Lake Constance.

The popularity of the aeroplane, and the widespread conviction which was noticeable a few years ago, that this type would be the machine of the future, were based upon the fact that it was built upon the principles which govern the flight of birds. Since we now understand the laws of flight, and improved materials of construction have enabled us to build flying machines that are gradually, if very slowly, approaching the bird in their ratio of power to weight, it was argued that the production of a successful flying machine was a matter of time merely. It is probable, however, that in coming to this conclusion, sufficient importance has not been attached to the human element, upon which the successful operation of the aeroplane is absolutely dependent. It would no doubt be possible to build an aeroplane that would carry a person at a fairly rapid speed through the air, provided the occupant of the machine possessed that God-given faculty by which the bird is able to preserve its equilibrium, adjusting the position of its weight and the inclination of its wings to the ever-changing velocity and direction of the wind, and the varying speed and direction of its own flight.

This matter of equilibrium is determined, in the aeroplane, by the inter-relation of several factors, such as the speed, the inclination of the supporting planes, the position of the center of gravity with regard to the center of area of these planes, and the inclination of the guiding tail. It requires rare quickness of perception and judgment to keep all these factors in the harmonious equipoise necessary to equilibrium, even under the favorable conditions of a perfectly still atmosphere; but when we remember that every change in the direction and strength of the wind calls for an instant readjustment of the machine, and that a moment's hesitation might result in a sudden dive earthward, the perils of aeroplane navigation will be evident. The fatal mishaps to Lilienthal, Pilcher and others were due to a failure to control the equilibrium, and the present indications are that as long as the balancing is dependent upon the sensations and voluntary control of the operator, aeroplane navigation will remain a very hazardous and fatal form of recreation.

It is evident that some method of automatic mechanical control is necessary, and the results achieved by Professor Langley on the Potomac River indicate that such control is within the possibilities of the future. In perfectly still air the Langley steam-driven aerodrome achieved a steady flight of three-quarters of a mile at a speed of thirty miles an hour. But although this was a truly wonderful result and speaks eloquently for the skill and unconquerable perseverance of the inventor, the aerodrome is to-day nothing more than a wonderfully ingenious toy. It is a far step from that to a machine of commercial or military utility, capable of carrying its freight in any direction in all possible conditions of wind and weather.

The airship (using that term to include all gas inflated machines), though not by any means so attractive as a scientific problem, seems to be at present the more practicable. For in this type the question of suspension in mid-air has no necessary relation to the speed, as in the case of the aeroplane, and the efforts of the operator may be devoted entirely to steering and propulsion. Given a sufficient volume of gas and a containing cylinder of the proper strength, there is theoretically no limit to the weight which may be lifted. It is in providing a motor sufficiently powerful to propel the huge structure against a strong opposing wind that the difficulty lies. This has never been accomplished as yet, and there is no expectation that even the mammoth Zeppelin airship will be able to make headway against anything stronger than a moderate breeze. Its proposed speed is 22 miles an hour, and hence it will be helpless against a wind of that velocity. Nevertheless, if this distinguished German succeeds in achieving this speed with an airship capable of carrying a crew of several men, he will have placed the problem of aerial navigation on a practical basis which it has never hitherto reached.

The Zeppelin airship, which is illustrated and described in the SUPPLEMENT of November 11, 1899, is of unprecedented size. It consists of a conical-ended cylinder 39 feet in diameter and 410 feet long, carrying two parallel, boatlike cars below it, in which are placed two 15 horse power benzine motors for driving the propellers. The hull consists of an aluminium framework surrounded with a strong netting, within which will be 17 separate, independent, airtight gas balloons, the arrangement resembling that of the watertight compartments of a steamship. The ship will be trimmed by means of a weight sliding on a cable suspended below the cars. By sliding the weight aft, the bow will be thrown up and the reaction of the air will cause the ship to rise; the contrary movement of the weight will depress the bow and cause the ship to sink. Unless some unforeseen difficulty arises, we may expect to learn the results of the trials of this Brobdingnagian at any moment, and their publication will go far to determine the possibilities of aerial navigation on a practical and commercially useful scale.

THE DALMENY EXPERIMENTS.

The great problem for the British farmer, and in fact the farmer in any old country, is how to produce the best possible crop at the least possible cost, so as to compete with the enormous quantities of grain and other agricultural products which are sent in from the United States, Argentina, and other cereal-producing countries. Artificial fertilizing is absolutely essential to successful farming in Great Britain, and the great importance of the subject was recognized early in the history of modern scientific agriculture. In 1843, the renowned Rothamsted experiments were started by Sir John Bennet Lawes, who has provided a heavy endowment fund, so that experiments can be carried on in perpetuity. For fifty-six years the same kind of grain crops have been grown on the same plots and the same kinds of fertilizers year after year, each section having one or more plots upon which crops have been grown continuously without any kind of manure. The value of these experiments has been very great, and was an inspiration to make many public bodies, societies, etc., establish similar experimental stations.

In recent years bacteriological science has proved beyond the possibility of cavil that in the great cycle of change, from the organic matter in the soil to the elaborate products which are absorbed by the roots of the plant, the bacteria of the soil are the great, and indeed the only agents employed. It is now a proved scientific fact that the decomposition of organic matter in the soil is due to bacterial action and to the action of various crops of soil organisms. It is also a proved fact that the wart-like excrescences on the roots of leguminous plants are the camping grounds of myriads of bacteria which possess the property of being able to absorb the free nitrogen of the atmosphere and render it favorable for the use of plants. This science has also shown that caustic lime will destroy the nitrifying and other advantageous soil organisms, whereas carbonate of lime is highly beneficial to them, and, in fact, where the organisms are found in the greatest numbers and greatest activity, it is absolutely essential to the due discharge of their function. Therefore, the bringing about in the soil of those conditions which favor the development and action of those nitrifying and other advantageous organisms is the great aim and end of scientific fertilizing; for the farmyard and artificial manures applied to the soil are not taken up direct by plants, but go in the first place to feed the crops of soil bacteria, which in turn provide the highly elaborated material to be absorbed by the roots of the plants. For several years it has been held as a proved scientific fact that the oxidation of organic matter in the soil, which was formerly held to be a purely chemical change, was due to the action of soil bacteria. The Nineteenth Century has just published a most interesting article by Mr. D. Young on the "Dalmeny Experiments," from which we obtain our information.

Some eighteen years ago, the two founders of what is called "New Soil Science" were interested in the study of soil bacteriology; one of them was John Hunter, and the other Professor M'Alpine. The discoveries of Pasteur and other investigators as to the paramount importance of having the right crops of yeast plants in the production of beer was doubtless the means by which Mr. Hunter was led to recognize the equally great importance of having in the soil the right crops of soil bacteria. The nodules on the roots of the Leguminosæ were first investigated, and as a result Messrs. Hunter and M'Alpine demonstrated the fact that the bacteria in these root nodules did possess the power of absorbing the free nitrogen of the atmosphere and render it available for the use of the plant. They then proceeded to carry out a series of investigations in regard to the nitrifying bacteria. At an early stage in their work they found there were several well-defined sets of bacteria concerned in the work whose final end is nitrification. They succeeded in isolating and cultivating the nitrous germ and they also isolated what they believed to be the nitric germ, but in the case of the latter they were for a time puzzled to find that they could not, from it in any ordinary culture media, produce nitrates. Finally they remembered the plan by which Napoleon was able to secure from the old mortar in the Paris stables a supply of nitrate for the manufacture of gunpowder. They accordingly added a small supply of mild lime in the form of mortar to the culture media, with the result that the nitric germs produce nitrates quickly. The experimenters thought that the old dressings of hot lime were a mistake, but that a small annual or biennial dressing of lime compost to the surface soil was essential in successful and scientific fertilizing.

Naturally their views were bitterly opposed, but at last the time came when the doctrines of the New Soil Science could be tested under the most favorable conditions. The post of land agent on Lord Roseberry's estates becoming vacant, a pupil of Mr. Hunter's, named Drysdale, was appointed. The latter commenced experimenting on a small scale with various fields, and with such satisfactory results that Lord Roseberry decided to extend the work. In 1895 a well equipped experimental station was established on his lordship's farm at Dalmeny Park, with Mr. Hunter as scientific adviser. The results of the experiments were carefully tabulated and would fill a good-sized volume. With a moderate dressing of farmyard manure supplemented with 4 cwt. of ground lime, applied at the working of the land, followed by 4 cwt. superphosphate, 1 cwt. of fermented bones, 2 cwt. of kainit and 1 cwt. of ammonium sulphate, the Dalmeny home farm produces crops which are the admiration of all.

The "Dalmeny Experiments" are of far-reaching importance. There are now, at least, six lime works which are kept constantly at work grinding lime owing to the ever-increasing demand for that substance, and the scientific authorities who had at first considered the new soil science as a heresy have been obliged to admit that nothing succeeds like success.

THE SECRETS OF OUR SUCCESS IN THE STEEL TRADE.

When the statistics of the steel trade of the United States for the year 1899 are completed, there is every probability, judging from the records for the past ten months, that this country will have produced a grand total of between twelve and thirteen million tons. This is equal to the total production of the whole world in 1871, and is fully one-half of the world's production ten years ago. We have not only outstripped every competitor, including Great Britain itself, but so rapid is the growth of the American industry, that the time is within measurable distance when even that country will be but a poor second in a comparative list of production.

It is now nearly half a century since the Hon. Abram S. Hewitt, who has always shown a firm grasp of the economics of the industry with which his name is so closely associated, stated that the essential conditions to building up an iron trade commensurate with the importance of the United States and the enormous demands of the future, were three. First, there must be an adequate supply of the raw materials, ore, coal and limestone; second, they must be so far contiguous, geographically, that they can be brought together at the furnace at small cost of transportation, and the product be cheaply placed at the various markets; and lastly, there must be no stint of capital to build, equip and carry on the works. Now, in view of the fact that these words of Mr. Hewitt, spoken in 1855, do actually describe the present favorable conditions in the United States, they may be taken as being truly prophetic.

As a matter of fact, everyone of these conditions is not only present, but it is fulfilled with a completeness far beyond the most sanguine forecast. In the first place, the United States possesses in the Lake Superior and adjacent iron mines the most extensive and most easily worked deposits in the world. Nature could not have placed the raw material in a more ideal and convenient form for cheap and expeditious recovery from its geological resting place; and science and art have nobly responded in providing the necessary excavating tools for the cheap mining and transportation of the ore to the smelting furnace. The iron mines of Lake Superior are matched by the vast coal fields of Pennsylvania, and the genius of the American engineer has devised a system of transportation by ship