runs to Los Angeles. At this plant the head of water is more than 1,900 feet, so that one cubic foot of water per second develops twenty gross horse-power. In Colorado, near Pike's Peak, an electric plant is operated with water under a head of 2,500 feet, which is believed to be the greatest in this country or the world, that has been developed. While such heads of water cannot, perhaps, be duplicated at developments in the East, numerous cities exist along the Appalachian chain of mountains, from Maine to Georgia, where water heads of 500 to 1,000 feet can be obtained for power plants. At a recent development in New England, a head of about 470 feet was procured for a pipe line some three miles long. The drainage area of the stream above the dam where the head of this pipe is located is only 15 square miles, and of this area the reservoir behind the dam covers 800 acres.

As there are 640 acres to the square mile, this reservoir covers 8.3 per cent of its drainage area. The storage capacity of this reservoir is 435,000,000 cubic feet, which represents a layer of water 1.01 feet thick on a level over its entire drainage area. In a case where the total drainage area is 24 square miles, the storage reservoirs cover 1,120 acres and have a combined capacity of 498,000,000 cubic feet of water. The generating station where the runoff from this 24 square miles is utilized under a head of 222 feet has a capacity of 1,600 kilowatts. Plans for a plant in the Berkshire Hills of Massachusetts, not yet built, show a water head of more than 800 feet.

THE DEVELOPMENT OF THE CAPITAINE PRODUCER-GAS MARINE ENGINE.

The application of the Capitaine producer-gas marine engine, the possibilities of which have been demonstrated in a very practical manner by the Thornycroft Shipbuilding Company, is being extensively developed in Great Britain. So far the utilization of this system of generating power has been confined to small vessels, the Thornycroft Company having only completed arrangements with the inventor to this end. The rights to manufacture and apply the invention to large vessels have been acquired by Messrs. Beardmore & Co., Ltd., who are carrying out some interesting experiments to this end.

This firm has under construction an installation of 500 horse-power, and this is by far the largest engine of this type that has been so far undertaken. Under these circumstances the construction of such an engine presents several problems that have not had to be encountered in the case of the smaller-powered plants. Yet there is a great opening for this type of engine, not only for propelling purposes, but for auxiliary machinery purposes, especially where weight of machinery and economy in coal consumption are of vital importance. The total weight of such an engine is about 75 per cent of the ordinary engines and boilers, while the fuel consumption is 50 per cent less.

This 500-horse-power plant will comprise five cylinders of the vertical type, working on the Otto cycle principle, and fitted with a suction gas producer specially designed to work continuously with ordinary bituminous coal. The framing of the engine is of plate steel exclusively with the exception of the cylinders, which are the only large parts of cast iron. By means of this design a rigid yet light construction is obtainable.

The builders have also designed a new type of reversing gear, which possesses several interesting and novel features. This gearing will enable the engine to run in either direction and dispense with feathering propellers, bevel gearing, and so forth for reversing. The gas producer is also being arranged so as to supply the engines with gas free from tar, and is to be fired by a mechanical stoker so designed as to prevent the formation of clinker when using bituminous coal.

When this engine is completed, it will first be submitted to exhaustive and severe trials on land under conditions resembling as near as possible those obtained at sea. If they should prove satisfactory, it will then be installed upon a Glasgow coasting steamship, and the firm will then proceed with the construction of an engine of 1,000 horse-power, for which the designs have been prepared, but the construction of which has been postponed until the results of the 500-horse-power engine have been obtained, so that any disadvantages or weak points that may develop may be eliminated from the larger engine. The engine now in hand will be completed and tested within the next two months.

That there are great possibilities for this system of generating power is evidenced by the practical interest that is being shown in the invention by the British Admiralty, who are also constructing a high-powered engine at Manchester, and which will also be subjected to a series of severe trials by the naval engineers. If the invention can be proved to be as successful in the larger sizes as it has been in smaller craft, it has a great future as the power generator in large vessels, and especially in bucket dredges and towing craft, where a maximum of power is desired at the minimum of expense, both as regards initial cost, space occupied, weight, and economical coal consumption.

HYBRIDIZATION OF PLANTS.

BY W. R. GILBERT.

It is a singular fact that it is only during the past century that hybridization, or cross-breeding of plants, has been practised.

Lord Bacon, more than 300 years ago, seems to have foreshadowed it, but it was generations before anyone attempted to solve the mystery.

Lord Bacon wrote: "The compounding or mixing of plants is not yet found out, which if it were, it would be one of the notable discoveries, for so you would have great varieties of fruits and flowers yet unknown."

Who was the first to cross a fruit or flowers we have no data to prove, but Mr. Knight, of Chelsea, England, was very much interested in, and practised the art of hybridization. When the secret was found out the practice soon became common, and some enthusiastic amateur horticulturists engaged in it. Since then the art of hybridization has been followed by many, and, as Bacon suggested, greatly improved and unknown varieties of fruits and flowers have been produced in rich abundance.

Perhaps in the amelioration of fruit it has been important, now marvels of the hybridist's skill are crowding upon us, and they seem to accomplish their aims with a certainty that is remarkable—for instance, in the case of the stoneless plum which Mr. Burbank, of California, after twenty-five years of study and experiment has been able to give to the world, and now the coreless apple of Mr. Spencer. It has taken these gentlemen years to accomplish the object they had in view, but to raise a new grain, fruit, or flower or vegetable of greatly superior qualities is worth a lifetime of patient and persevering effort, because it contributes to the welfare of the human race, and the comfort of the lower animals.

Cross-breeding is the most important, useful and fascinating branch of horticulture and sometimes very remunerative.

In order to obtain a new variety it is only necessary to exercise some judgment, and select two parents of certain qualities which are of the same, or of very closely allied species, and cross them for a new intermediate variety, which will blend the good points of both, and thereby effect an improvement; thus an early, but insipid pear, if crossed with one of fine flavor, but lacking the desirable qualities as to habit of growth or productiveness, will be likely to bring a variety which in some essential points will surpass either of its parents.

The "Goe's Golden Drop" plum was raised by crossing the Green Gage with the Magnum Bonum plum; the Elton cherry was raised by crossing the Byarrean with the White-heart, and the combinations have produced the two invaluable fruits mentioned.

The power to cross-breed is limited by a wise provision of nature to prevent the generation of monstrosities. A cross-bred plant is a sub-variety raised between two varieties of the same species. Some nearly allied species are capable of fertilizing each other and these are pure hybrids or mules, and, like animals so bred, are incapable of producing perfect seed. No one has ever succeeded in causing the pear to fertilize the apple, or the gooseberry the currant. Before people were so well informed on these subjects as they now are it was believed that wonders could be brought about by fertilizing an orange with a pomegranate or a red rose with a black currant, but these fancies are no longer accepted as being possible.

Now, as to the *modus operandi* of the artificial crossing of plants. Take the blossom of a cherry, for an example, which is directly connected with the embryo seed; the numerous surrounding threads are the stamens at the summit of which are little sacks which secrete the powder called pollen. The pistil has its base in the embryo fruit and at its summit is the stigma; the pistil is also called the style, and is the stalk or tube between the ovary and the stigma; on this stigma is a sticky substance, when it has arrived at maturity, to which the pollen adheres and thus the seed is fertilized. Now, if we fertilize the pistil of one flower with the pollen of another we shall obtain a variety with the characteristics of both parents.

The process of obtaining cross breeds is easily performed. When the tree blooms, which we intend to make the mother of the improved race, we select one of the blossoms not fully expanded; with a pair of sharp scissors we cut off the antlers or pollen sacks. As soon as the blossom is fully expanded, collect with a camel-hair brush the pollen from a fully blown flower taken from the tree we intend to be the male parent. Apply the pollen, and leave it upon the point of the stigma. It is safe to cover the flower thus operated upon with a bag made of thin gauze to prevent insects getting beforehand with us in applying the pollen. To sum up, the two essential points are: First, to be very careful to remove the antlers before they are sufficiently mature to have fertilized the pistil; second, to apply the pollen when it is in perfection, that is, dry and powdery, and when the stigma is moist and in condition to assimilate it. Seedless fruit is produced by removing the pistil before it has been pollenated, so that the fruit will form and contain but few if any seeds, and by selecting those which have the least seed and repeating the process in course of years seedless varieties will be the result.

SCIENCE NOTES.

For the purposes of studying the causes of sorotchte or mountain sickness, and the influence of the temperature and climate of high altitudes upon general nutrition, two eminent French medical authorities, Drs. Guillemard and Moog, during last July made a stay at the Mont Blanc observatory with the astronomer M. Janssen. According to the results of their investigations the diminished tension of the oxygen of the atmosphere clogs the process of oxidation, and this sets up an elaboration of toxic substances, the retention of which causes symptoms of autointoxication and accounts for the symptoms of mountain sickness. Acclimatization, however, results in a few days, and the symptoms pass away under circumstances resembling those accompanying the passing of the crisis in infectious maladies.

In the northern hemisphere the greatest cold seems to have been observed at Werchojansk, in Siberia, where it is stated that the thermometer goes down as low as —69.8 deg. C. However, according to the information which has been brought by the Russian artist Borrissoff, certain parts of Nova Zembla seem to show at least as low a temperature as the above. The Bulletin of the Société Astronomique states that in an excursion which M. Borrissoff made lately in the Strait of Matotchkin, he discovered underneath a case a box containing two thermometers, one a maximum and the other a minimum-recording thermometer. It is supposed that these instruments belonged to Höfer, an Austrian geologist, who made an expedition to this spot in 1872. One of the thermometers was found to have registered the temperature of +15 as a maximum, while the second instrument showed that the greatest cold had been —70 deg. C. This value seems to be the extreme cold which has been reached in this region for thirty years past.

The variations in the thickness of the hair upon the same individual have been studied by the Japanese scientist Matsura and he makes some interesting observations. It is known that in certain diseases we find among other differences of growth, very marked variations in the growth of the finger nails both in length and thickness. It is found that the hair is also influenced, and all the affections which act upon the general health bring about a diminution in the thickness of the hair. The medullary layer may even be interrupted and the hard layer which it contains may disappear. Observations made upon a hair will therefore show the variations in thickness according to certain maladies and the length of the affected part or the thinner portion of the hair gives an idea of the duration of the malady, and even of slighter affections. The variations are naturally more strongly marked in the case of coarse-haired races than for others. Provided the hair had never been cut, the subject would have his pathologic history written, so to speak, in capillary terms.

A new process for the manufacture of hydrogen gas has been brought out in Europe not long ago, and is designed to replace the usual method of sulphuric acid and iron or zinc. In the new process the reaction of the alkaline hydrates upon metallic aluminium is utilized. This reaction is $2Al+3NaOH=3H+AlO_3Na_3$. When once commenced, the metal is attacked by the soda solution with great energy. The gas is produced very rapidly and the liquid heats up to the boiling point. Theoretically we need 0.810 kilogramme of aluminium and 3.6 of caustic soda to produce 1 cubic meter of hydrogen, but in practice owing to the impurities in the metal and the soda, we require 4.68 kilogrammes of caustic soda. The process gives some advantage as to saving in material which is to be transported, seeing that we need but 5 kilogrammes of material per cubic meter of gas, while the acid process takes 7 kilogrammes. But the cost of production is much higher and comes to at least $0.72 per cubic meter. This process was used by the Russian aerostatic corps during the recent war.

An interesting effort to apply the Parsons turbine to locomotive propulsion is being made by Mr. Hugh Reid, a well-known British locomotive engineer. This inventor has designed a self-contained electrical locomotive, which will generate its own current by means of a boiler and a condensing Parsons turbine. He has also devised an air-cooled condenser of somewhat novel design for use with the same, and the forthcoming experiments with this locomotive are being anticipated with great interest by British engineers.