A BALANCED LOCOMOTIVE.

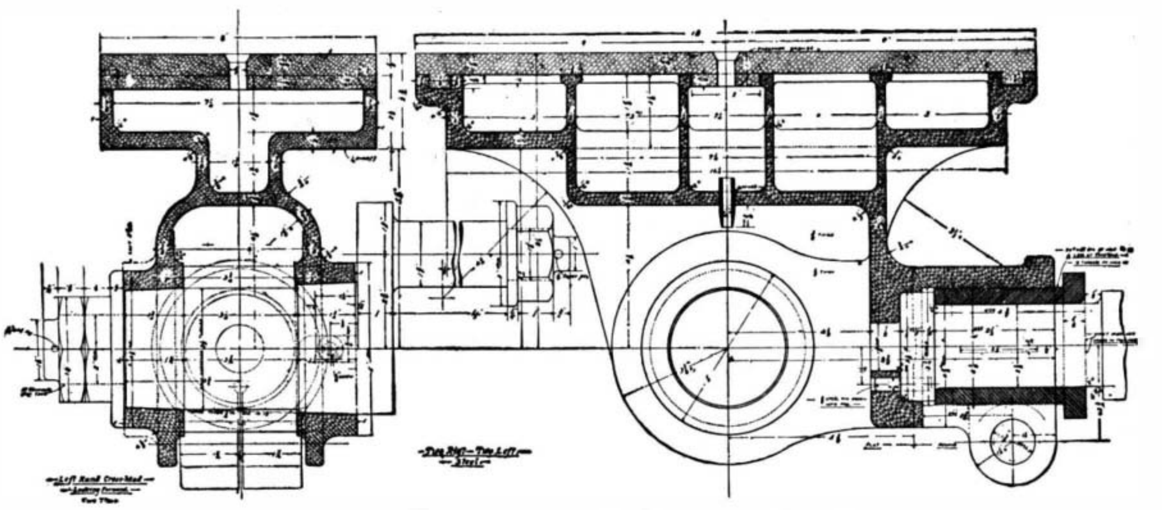
The up to date locomotive is the result of a long process of evolution, in which is embodied the results of many years of painstaking experiment. Considering the many arbitrary limitations of size and weight to which it is subject, it is as perfect a piece of mechanism as can be found anywhere to-day. There is one important particular, however, in which the locomotive shows a defect, which, in these days of high speed, has become very marked, and is causing locomotive engineers to do a lot of hard thinking.

We refer to the difficulties of counterbalancing.

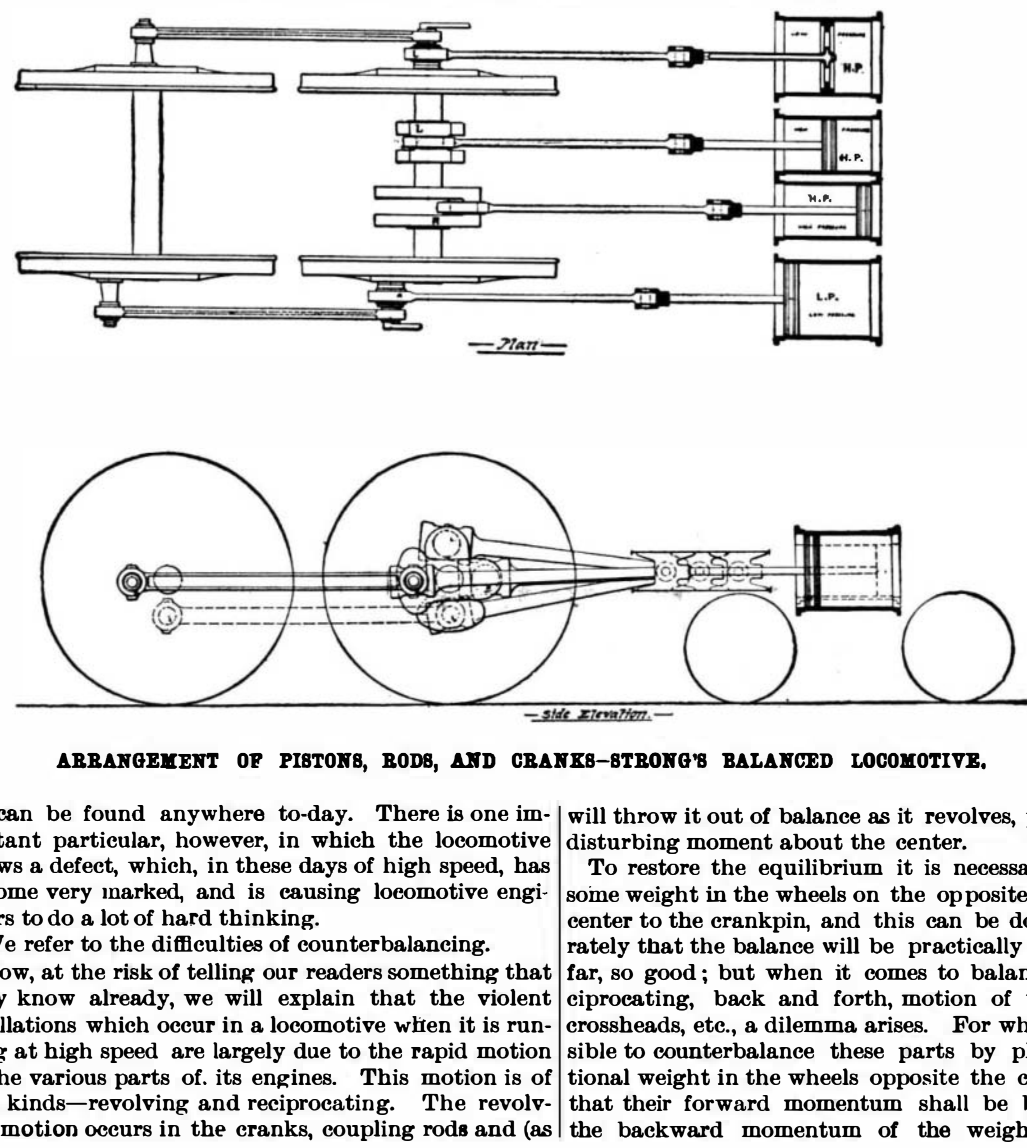
Now, at the risk of telling our readers something that they know already, we will explain that the violent oscillations which occur in a locomotive when it is running at high speed are largely due to the rapid motion of the various parts of its engines. This motion is of two kinds—revolving and reciprocating. The revolving motion occurs in the cranks, coupling rods and (as it is usually reckoned) the rear half of the main rods; the reciprocating motion in the front half of the main rods, the crossheads, piston rods, and pistons. Now it is evident that when the heavy coupling rods, crank pins, etc., weighing many hundreds of pounds are attached to the wheel a foot or so from the center, they will throw it out of balance as it revolves, producing a disturbing moment about the center.

To restore the equilibrium it is necessary to place some weight in the wheels on the opposite side of the center to the crankpin, and this can be done so accurately that the balance will be practically perfect. So far, so good; but when it comes to balancing the reciprocating, back and forth, motion of the pistons, crossheads, etc., a dilemma arises. For while it is possible to counterbalance these parts by placing additional weight in the wheels opposite the crankpins, so that their forward momentum shall be balanced by the backward momentum of the weights, and vice versa, there will be a vertical disturbance of the balance of the wheels which will be exactly equal to the momentum of these added weights. The effect of this "excess balance," as it is called, will be to cause a violent vertical oscillation of the locomotive. On the upward half of the revolution the momentum of the excess weight will tend to lift the wheel, on the downward half to depress it. So powerful is this action that wheels have at times been lifted clear of the track, and the downward momentum has had the dynamic force of a blow, bending the steel rail at every revolution. On the other hand, if the reciprocating counterbalance be left out altogether, the same "hammering" effect is set up in a horizontal direction by the back and forth momentum of the reciprocating parts. This communicates a violent vibration to the whole train, which at high speeds becomes extremely uncomfortable. The locomotive builder is thus placed "between the devil and the deep sea;" and in his dilemma he has taken the only course left open to him, and compromised the matter by counterbalancing only one-half or two-thirds of the reciprocating parts as seems best (or least bad) in his judgment.

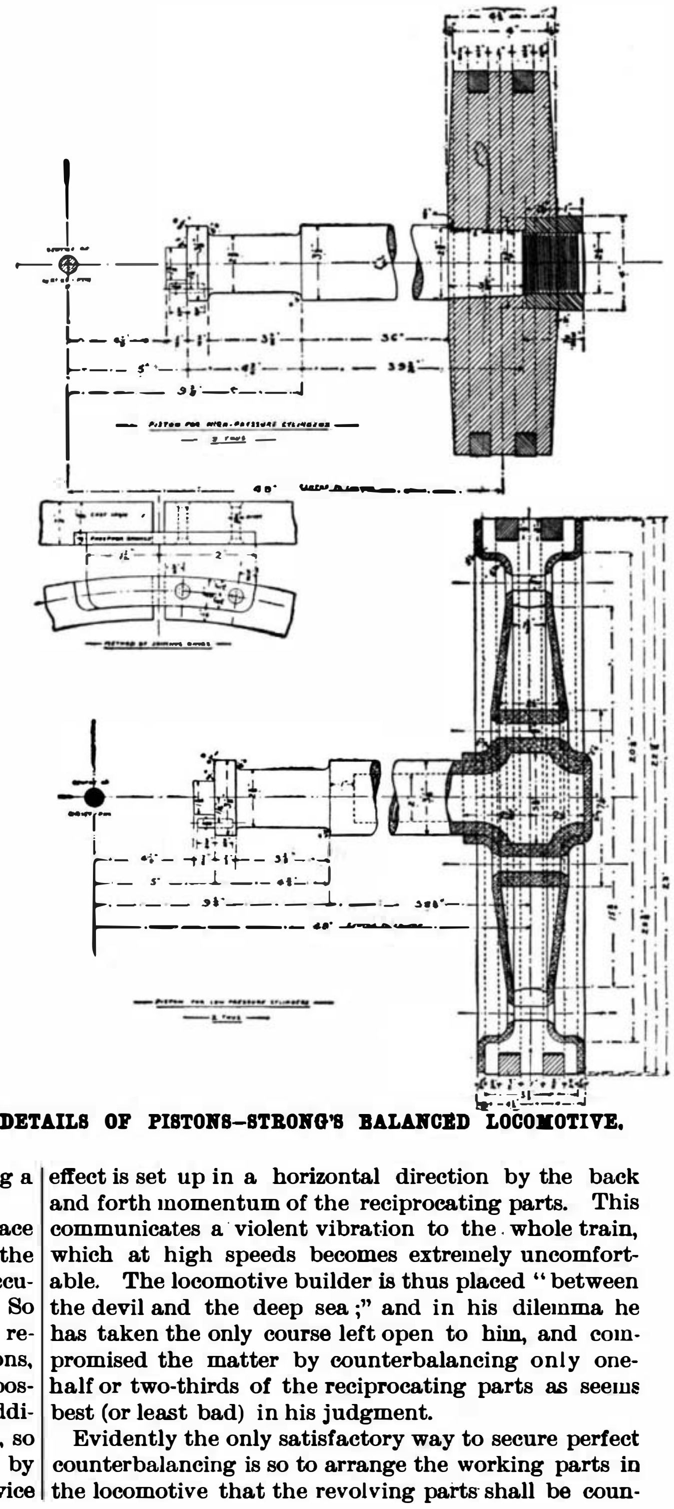
Evidently the only satisfactory way to secure perfect counterbalancing is so to arrange the working parts in the locomotive that the revolving parts shall be coun-



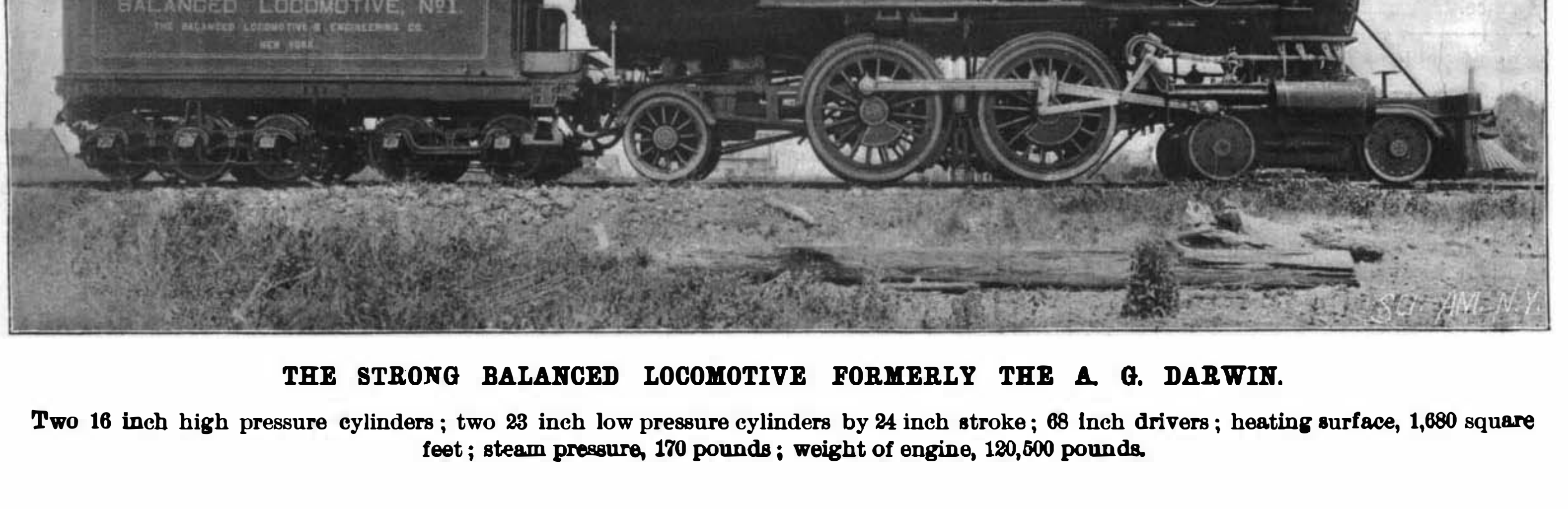
DETAILS OF CROSSHEAD—STRONG'S BALANCED LOCOMOTIVE.



ARRANGEMENT OF PISTONS, RODS, AND CRANKS—STRONG'S BALANCED LOCOMOTIVE.



DETAILS OF PISTONS—STRONG'S BALANCED LOCOMOTIVE.



THE STRONG BALANCED LOCOMOTIVE FORMERLY THE A. G. DARWIN.

Two 16 inch high pressure cylinders; two 23 inch low pressure cylinders by 24 inch stroke; 68 inch drivers; heating surface, 1,680 square feet; steam pressure, 170 pounds; weight of engine, 120,500 pounds.

© 1896 SCIENTIFIC AMERICAN, INC.

terbalanced by revolving parts and the reciprocating parts by reciprocating parts throughout the complete revolutions of the wheels.

The locomotive which is shown in the accompanying illustration has been designed on these lines. The general outlines will be familiar to many of our readers, who will recognize it as the famous A. G. Darwin, one of the Strong locomotives which attracted much attention some half dozen years ago. The frame, wheels, boiler, and tender are the same; but here the likeness stops. In place of the former 19 inch cylinders there is a compound engine with four cylinders, which are arranged in pairs on either side of each side frame, as shown in the plan view. On the inside of the frames are two 16 inch high pressure cylinders and on the outside are two 23 inch low pressure cylinders. The cranks for the former are turned in the main drivng axle, and the low pressure cylinders are connected to outside crank pins in the usual way. The cranks of each pair of high and low pressure cylinders are set at 180°, so that the low pressure crank pin is moving forward when the high pressure crank axle is moving backward, and vice versa. In this way the reciprocating parts of each pair of cylinders are made to counterbalance each other, and a locomotive is produced whose center of gravity is constant, whether she be running or at rest. The pair of cranks on one side are placed at the quarter stroke to those on the other side. In order to make the reciprocating parts of the adjacent pair of high and low pressure cylinders exactly counterbalance, Mr. Strong has designed a special form of low pressure piston and rod. As shown in the drawing, both piston and rod are hollow, the piston being formed of two dished steel plates, the end of the hollow piston rod being flanged out and fitting into shoulders on the inside of the steel plates to which it is riveted. At the periphery the plates are riveted to an annular ring in which the customary grooves are cut for the piston rings. The high pressure piston and rod are made solid and equal in weight to the low pressure piston and rod. The weight of the reciprocating parts is further reduced by using a hollow crosshead of very light design, as shown in the accompanying drawing.

The revolving parts are balanced by placing weights in the wheels in the usual way, except that the counterbalances are placed at the same distance from the center as the crank pin, instead of at the circumference of the wheel. Mr. George S. Strong, the designer, claims that better results are obtained by this arrangement, inasmuch as the balancing is perfect at all speeds.

The valve gear, which is an adaptation of the well known Walshaert gear, so largely used in Europe, is designed to give an equal lead at all points of cut-off. The valves are of the gridiron type, working vertically, and they are operated from the outside crankpin, which is seen in the illustration attached to the main driver. Motion is given by a connecting rod which is attached to a crank arm on the link shaft. The links have a fixed point of revolution, the blocks sliding in the links instead of the links on the blocks. The motion is thence transmitted to the rocking shafts of the valves, which will be seen located above the cylinders. The gear which is seen midway between the link blocks and the valves is operated from the crosshead and imparts the necessary lead and lap to the valves. The chief advantage claimed for this arrangement of valves and valve gear is that by providing large port areas (in this case as high as 11 per cent of the piston areas) the steam has a very free admission and exit to and from the cylinders, and wire drawing, that most fruitful source of loss at high speed, is prevented.

Altogether, the balanced locomotive, as it is called, presents many features of design which render it well suited to heavy express service. As the perfection of the balance renders a high piston speed possible, the size of the driving wheels may be reduced, bringing a consequent increase in the tractive power of the locomotive. As an evidence of the smoothness of the running, Mr. J. W. Beach, who superintended the reconstruction and trial trip, states that he was able to read a newspaper as he stood upon the foot plates when the locomotive was running at a speed of 70 miles an hour. In the next week's issue of the SUPPLEMENT we shall give full drawings and description of the A. G. Darwin as she was originally built, together with some details of her performance.

The Treatment of Snake Bite by Calcium Chloride.

The Indian Lancet for August 16 publishes the following abstract from the Semaine Médicale: Phisalix and Bertrand reported the result of experiments with calcium chloride in cases of snake bite at a recent meeting of the Académie des Sciences. Its therapeutic action is not, as Calmette thought, due to the formation of some substance neutralizing the poison, or to its entering the circulation and there destroying the poison as it would in a test tube, but it depends simply on its local effect: it destroys the poison locally, causes the tissue to slough, and so prevents absorption of the toxic material. Hence it is concluded that the injections of calcium chloride must be made deep at the actual spot where the fangs entered, and that they are useless if made in any other part.

Recent Archæological News.

"Grave goods" is the comprehensive term now used in England to describe what archæologists find in stripping ancient tombs. In the Carthage cemetery this year 120 tombs have been found and opened by Father Delattre, some Greek vases with figures of animals being among the grave goods.

An act of official vandalism has been perpetrated at Spalato, in Dalmatia, the great palace of Diocletian. The beautiful Romanesque tower on Roman foundations at the entrance of the emperor's mausoleum has been torn down, and a new tower is rising in its stead, into which capitals and sculptured stones of all dates from the third century to the twelfth are being built.

Henry Brest, through whom the Venus de Milo came into the hands of the French in 1818, has just died, over a hundred years old, on the island of Milo, where he had married a Greek woman. He happened to be on the spot when the peasants first dug up the statue, and, struck by its beauty, induced them to keep the discovery secret, notified the French consul, and arranged for the delivery of the statue to the crew of the French man-of-war that came to Milo to carry it away.

At Mycenae a vaulted chamber similar to the so-called Treasury of Atreus, the Treasury of Orchomenos and other structures, which are now known to be tombs, has been discovered. The wonderful discoveries which Schliemann made in these tombs, in which, as he thought, he found the remains of Agamemnon, will be remembered; and the present one has the advantage over nearly all the others known, of being practically intact, the fall of a huge mass of earth in early times, says the American Architect, having protected it from spoliation.

Among the recent finds of the French expedition in Babylonia, which has been and is still working at Telo, are a number of dated cuneiform tablets of Sargon the First and of his son Naram-Sin. These have now reached Constantinople, and within the last two months have been submitted to the examination of Monsieur Heuzey, director of the Museum of the Louvre, and of Prof. Hilprecht, who has been retained by the Turkish government to decipher and classify the objects found by both expeditions. By this important find, all questions as to the mythical character of Sargon are put an end to, and he is shown to have been a real person. The contents of the so-called Oman tablet are definitely decided to be historical and not mythical.

Mr. Newberry tells of the labors of the Egyptologist in making out inscriptions, and in the Academy he writes that when obtaining a complete copy of the great tomb of Rekhmara he spent "six months' hard work on ladders and by candle light." The Necropolis of Thebes has been investigated by Champollion, Rosellini, Wilkinson, Lepsius, Ebers, Brugsch Pasha, but its wonders have not yet been by any means exhausted. Mr. Newberry has devoted his attention to the private tombs, and many of these have inscriptions and pictures of great interest. Access to them was difficult, because they were inhabited by the fellahin. In one tomb was found a record of the engineer employed by Queen Hatshepsut, who superintended the cutting of the two great obelisks at Karnak.

The special wealth of the Fen country of England in churches of the highest class, some of them almost cathedral-like in dimension, far exceeding the needs of the sparse agricultural population now around them, must impress us with something like astonishment when we remember that building materials, whether stone or timber, were necessarily brought from less watery districts. In the course of some drainage operations in Lincolnshire, many years ago, an ancient barge was discovered laden with blocks of stone. Its timbers were black with age and long immersion, says Good Words, like the well known "Fen oak," and there can be no doubt that it had been accidentally sunk in the "leam" or watercourse, dug, perhaps, for the express purpose of conveying heavy materials by water carriage to one of the churches or abbeys in course of construction five or six centuries ago.

A novel anthropological discovery was made recently three miles from Waynesburg, in the southwestern corner of Pennsylvania, says Nature. A laborer, while plowing, struck a number of stones, which proved to be graves of a character different from any heretofore discovered. Twenty vaults were found, each twenty-seven inches long, seventeen inches wide, and twelve inches deep, and each covered with a stone forty-two inches long, three inches thick, and twenty-eight inches wide at the head, thirty inches in the widest and twenty-four inches in the narrowest part. The stones were six inches below the surface of the ground. Each vault contained a skeleton of diminutive size, doubled up so as to occupy only eighteen inches of space, with the heads all in an unnatural position, and all facing the south. Under each skull was a turtle, placed as if for a pillow; and in many of the graves were skeletons of birds. The graves were arranged in the segment of a circle of almost four hundred feet in diameter. Many bone beads were found in the graves, but only one piece of metal, a small crescent shaped copper ornament.

Science Notes.

The preservation of the remains of the famous walls of Antoninus, between the Firths of Clyde and Forth, built in 140 A. D., has been occupying the attention of the "National Trust for Places of Historic Interest or Natural Beauty." The Secretary of State for Scotland has visited the remains and it is believed that steps will be taken to preserve them.

A series of fêtes have been celebrated at Alais, in the center of the great mulberry and silkworm district of France, in commemoration of the services rendered by Pasteur to sericulture. A statue of Pasteur was unveiled during the celebrations; and a solemn service was celebrated in the cathedral in commemoration of the first anniversary of his death, which occurred on September 28, 1895.

Analysis of food is enlisting the services of Roentgen rays for the discovery of adulteration. A recent communication from M. Ranvez speaks favorably of the new method. In pictures so obtained of powdered materials thinly scattered on a sheet of glass, the presence of any of the mineral adulterants commonly used is plainly visible, on account of the rays not being able to penetrate them.

L'Industrie Electrique gives the following simple rule for converting Fahrenheit to Centigrade degrees. Subtract 32 degrees and divide by 2; then add to this $\frac{1}{10}$ of itself, and, if further accuracy is desired, $\frac{1}{100}$ more. For instance, if it is required to find the number of Centigrade degrees corresponding to 72 degrees Fahrenheit, subtract 32 and divide by 2, giving 20; adding $\frac{1}{10}$ more gives 22, and, for greater accuracy, another $\frac{1}{100}$ gives 22·2. The method is not as simple when applied to the reverse calculation, but possesses some interest.

The "International Cloud Atlas" may be purchased of MM. Gauthier-Villars et Fils 55 Quai des Grandes Augustins, Paris, for 14 f. a copy, says Science. The "Atlas," which contains 28 views, is now the official cloud atlas of the world, and the illustrations in it are the types to which all cloud forms must hereafter be referred. It is the work of the International Cloud Committee, appointed by the International Meteorological Conference held at Munich in 1891, and the standard types now adopted were selected from over 300 photographs collected from all parts of the world.

The influence of moisture on vegetation has been found by M. Edmond Gain to vary greatly at different periods in the growth of the plants. As a rule, water is urgently needed when the first leaves are appearing, then little is called for until just before blossoming, when a large supply is demanded. The fruit is best perfected in comparative dryness. Very few plants require constant moisture, and in all experiments tried the plants that were watered at the two critical seasons of first growth and the beginning of blossoming did as well as those that were constantly watered. Moisture in the soil favored increase in the number of fruit, seeds and roots, while dryness tended to promote greater size and perfection of seeds and tubers.

What appears to be an example of a new class of phenomena was shown at the meeting of the British Association by Prof. Liebreich, of Berlin, says the English Mechanic. He advanced as a deduction the general proposition that liquids, in proportion as they were placed in confined spaces, acquire, by equilibric reactions, the properties of solids, and that friction in such fluids has a bearing of considerable importance on chemical reaction. One of the experiments was that of sinking a piece of nickel attached to a float in water, and drawing it down to the bottom of the vessel by magnetic attraction. Prof. Liebreich showed that the float did not again rise quite to the surface, and this he attributed to friction in the fluid. He made a kindred experiment with two kinds of glycerine, one kind of which slightly reduced specific gravity. By means of a specially constructed apparatus he showed that the lighter liquid did not rise quite to the surface of the heavier, if permitted to percolate through it.

According to Dr. James Croll's estimate, the ice sheet at the South Pole is at this age several miles in thickness, its upper surface being above the line of perpetual snow, and therefore not capable of melting away during the warm eras succeeding glacial periods. Further, when such an enormous mass of ice is again incrusted about the earth's surface, as some geologists believe may be the case in the process of time, the consistent supposition is that as soon as it begins to yield once more to the influences of a milder atmosphere, as its counterpart did long ages ago, the same process of flooding great areas of the earth will be repeated, and the same remarkable evidences of the presence of seas and oceans that no longer endure will be left behind. The theory entertained by Alfred R. Wallace is much to the point, namely, that as a past glacial age was melting into the tertiary period, the seas in the northern hemisphere covered a much larger area than now, and extended across central Europe and parts of western Asia, and the Arctic Ocean was likewise enlarged. It is well known, by geological evidences not admitting of any question, that the lowlands of Europe were submerged and that the Baltic, Caspian, and neighboring seas were simply a part of the vast Atlantic Ocean, instead of being landlocked waters as they are now.

© 1896 SCIENTIFIC AMERICAN, INC.