curve of similar radius and of 93° 58', the road curves along the face of the hill, gradually rising and crossing the Hillside wagon road, which course on the ascent is now in a general direction to the north, until at an elevation of 110 ft. it enters the northern loop, and with a radius of 60 ft. goes around a curve of 215° 16'. The course is now to the southwest, and, still climbing the hill, the line crosses near the 140 foot contour line for a second time the Hillside wagon road, and going through an arc of 100° 32' with 100 ft. radius, it reaches its destination 160 feet above its commencement and connects with the rest of the system.

The road is built in the most substantial manner, parts being cut out of the face of the hill, other parts being filled and substantial retaining walls being applied when necessary. One of the latter is 70 feet high. Stone ballasting is used throughout, the material of the hillside supplying the best possible material, trap rock, for these purposes. The railroad tracks are crossed by a 92 foot lattice girder, the most considerable bridge on the line. Fifty-six pound steel rails are used for the cars to run on, and these rails are re-enforced with 32 pound guard rails laid close to them and inside. The cost of the work was $120,000 for the structural part alone. It was built by Mr. Miles Tierney as contractor, with Mr. C. B. Brush as chief engineer. The surfacing and finishing of the road is done under the immediate direction of Mr. Wm. H. Starr, formerly of the Erie Railroad, who is now general manager of the road and in charge of its operation. Mr. Tierney is now president of the North Hudson County Railway Company.

The power for the Hillside line is supplied by a 14,000 h. p. compound Corliss engine in the power station of the Hudson Electric Company.

The route involves maximum grades of 51½ per cent, and on the curves a grade of 1½ per cent is not exceeded. The road is reached by the Fourteenth Street Ferry, directly from this city. On reaching the top of the hill the passenger is put in communication at once, by means of the other lines of the company, with all of the elevated area beginning at Jersey City Heights on the south and ending with Guttenburg on the north. The North Hudson County Railway Company operates about fifty miles of road, including twenty-four miles of horse railroad, nineteen miles of trolley and seven miles of steam railroad. A very complete system of interchanging makes the entire area accessible. The road carries about 17,000,000 passengers per annum.

The Consumption of Artificial Manures.

An estimate has been made in the *Journal* of the American Chemical Society of the world's annual consumption of these fertilizers, which is put at a total of 5,500,000 tons, made up of the following items:

	Tons.
United States	1,550,000
Germany	1,300,000
France	1,000,000
Great Britain	1,000,000
Belgium and Holland	300,000
Scandinavia	100,000
Spain, Italy, and Austria	250,000

These figures are, necessarily perhaps, only approximate, but with regard to the one million tons estimated for this country, it is discoverable from another source that the quantity of manures imported into the United Kingdom in the three years ended 1891 averaged 600,000 tons annually, so that a considerable quantity for home consumption must have been supplied within the kingdom itself, in the shape of waste from gas works and chemical manufactures. Among commercial manures would be included guanos, nitrate of soda, sulphate of ammonia, potash salts, basic slag, and other mineral phosphates, together with additional sources of phosphatic fertilizers.

A hope has long been cherished by English wheat growers that as the necessity for applying manures to North American lands becomes more pressing, the cost of wheat growing will have a prohibitive influence upon the export of the bread cereal to this country. Apart from the possibility that before such a time arrives the wheat-exporting capacity of Argentina, and even of South Africa, will have greatly developed, it will nevertheless surprise many people to learn that in the United States the consumption of artificial manures is already half as large again as it is in the United Kingdom. On the other hand, there cannot be much doubt that the quantity of farmyard manure put upon the land is, in an ordinary year, much less in the United States than in this country. It appears that the consumption of commercial manures has grown very rapidly in the last twenty years in the Atlantic, and especially in the South Atlantic States. Their use, moreover, is steadily on the increase in the Central and Gulf States, and they are gradually passing into consumption in the less remote and more thickly populated of the Western States.—*Chem. Tr. Journal.*

What Becomes of All the Lumber.

It is estimated that, of the general lumber product, 35 per cent goes into building, 45 per cent into railroads and miscellaneous uses, and 20 per cent into boxes.

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TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

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THE UTILIZATION OF THE WASTE ENERGY OF THE WORLD.

The solicitude displayed by the individuals of the human race of one generation for those of subsequent generations is a very variable quantity. Many who claim great enlightenment profess to regard the lot of the twentieth or the twenty-first century man with considerable solicitude, fearing that the consumption of accumulated stores of terrestrial energy by the present generation will result in leaving to our successors a very impoverished globe indeed for their habitation. It is assumed that a day will come when the wealth of fuel accumulated in preceding geological eras, and consolidated into usable shape by the metamorphoses of ages, will be exhausted, and mankind will be without fuel. By the best geologists this is regarded as no fancy sketch. Coal is not forming, the natural growth of wood is quite insufficient to supply the demand for fuel, and the coal mines will eventually be emptied.

Curiously enough, a parallel occurrence is now going on before us. But a few years ago the natural gas industry took great dimensions. The almost uncontrollable flow of gas from gas wells was the basis for the most extensive operations; glass and steel furnaces in the industrial world, street lamps, house service, both for fuel and illumination, were supplied by natural gas, and the entire gas region became the scene of a prodigality on nature's part never equaled in impressiveness. The general assumption was that the future might take care of itself; hardly a thought was given to economizing the supply, and it now appears as if that future has come upon us, for, in accordance with the predictions of one of our most eminent geologists, the end seems in sight. Natural gas in a very few years will be virtually a thing of the past.

It is an open question how long after the extensive application of the steam engine economy of fuel began to be considered. Certain it is that a comparatively early type of engine to-day is in use as one of the most economical. The Cornish engine has some very fine examples in the most modern practice. The early steamships were almost failures on account of their coal consumption, and steamship constructors, having a double inducement to save fuel, both to get rid of a non-paying cargo and to save coal bills, have done their utmost to effect economy. Hydraulic engineers have taken a professional pride in reducing coal consumption, the "duties" of the great pumping engines of the country being quoted far and wide.

Good work has been done, the steam engine being gradually brought, perhaps, as near perfection as its inherent defects will permit. But simultaneously with this the horse power of the world's engines is increasing, and coal is being burned in greater and greater quantities. It seems clear that natural sources of energy must in the near future assume a greater importance than they have hitherto. Electricity, whose powers are as apt to be overestimated by the public as underestimated by the professional world, will be an important factor in this. The operations at Niagara Falls will be an illustration of a return to the principles of olden times, with appliances of the day. For it is a striking fact that our forefathers utilized the powers of nature to a vastly greater scale proportionately than we do. The horse power hours of wind energy utilized by windmills and sailing vessels was proportionately great for the era before steam; to-day the aggregate is very large, but the proportional amount compared with steam is small. The farmers throughout the country a hundred years ago took their grain to grist mills driven generally by water power, sometimes by wind power. Modern improvement has replaced those sources of energy by steam—the future generation may yet have to return to them.

The amount of energy as far as we are concerned absolutely wasted in wind and tidal motions and in evaporation by the sun exceeds the imagination of man. Suppose a waterway such as Long Island Sound to be white with the sails of vessels. Each one utilizes a portion of the energy of the wind which its sails intercept. But remembering how high the wind prism may be, and comparing the sail area with the probable cross sectional area of the prism in question, the absolute insignificance of the proportion used in driving a fleet of ships may be realized.

The wind expends some of its energy in producing waves, which, besides making a sea voyage a misery to many, and besides foundering many a ship in open water, absolutely impede the progress of a vessel. But when we see these waves rising and lowering successively, wave after wave, a six or eight thousand ton mass, making it uselessly roll and pitch, the waste of energy exhibited by a million square miles of stormy water exceeds computation. The same applies to the tides. If the power of the tons of water that rise and fall forty to sixty feet in the Bay of Fundy could be utilized and distributed, it would replace a vast quantity of steam energy.

Electricity is often spoken of as a possible method of heating, but the fact is overlooked that the energy in almost all cases is originally produced at an enormous waste by the steam engine. But were it produced by natural causes, then this objection would disappear, and at once the possibility of electric heating is manifest. The dynamo of this day presents a very good method of changing the kinetic energies of nature, found in waterfalls, in the winds and in the tides, into heat energy. The trolley railroads exhibit the marvelous adaptability of electricity for the transmission of power.

Prof. Langley's recent investigations show that the air in motion possesses energy independent of its total flow, the variations in velocity affording a possible clew to an explanation of the soaring of birds. The earth is a center of enormous energies, of which an infinitesimal part only is utilized by man. With the exhaustion of coal will come about the necessity of utilizing some of these energies. The future man may eat a meal cooked by the tidal flow, may traverse the ocean in boats driven by wave engines, and may regard the steam engine as a relic of a semi-barbaric age—fully barbaric in its reckless waste of the accumulated riches of the past.

We need hardly worry ourselves about our posterity in a world without coal. The energies of nature are sufficient to do the work of mankind many times over, and possibly to form coal again out of the carbonic acid gas of the atmosphere. Electricity has already progressed far enough to give a hint at least of its future possibilities. It may yet be replaced by some more efficient agent for the transformation and transmission of energies.

Storage Battery Lighting and Car Propulsion.

In 1890 a train of cars on the Big Four Railway was equipped with the Silvey batteries [W. L. Silvey, of Dayton, Ohio], using twelve cells to each car and ten 16 c. p. 25 volt lamps. The light was first operated as an experiment during a run of 90,000 miles between Cincinnati and Dayton, Ohio. As a result, fifty-five cars were similarly equipped on the C. & O. R.R. running between Cincinnati and New York, and during three years no such thing as a short-circuited cell or buckled plate has ever occurred. The relative cost of the coal oil, Pintsch gas and Silvey storage battery incandescent light for the year 1893, after three years of constant use, is shown by the report of chief electrician W. S. Greene, of the C. & O. R.R., just published, to be as follows:

Electric light costs $17.73 per year per lamp; oil lights cost $24.12 per year per lamp; and Pintsch gas light costs $29.42 per year per gas burner or tip. The relative candle power of each light is as follows: Oil 10 candle power, gas 8 candle power, and electric light 16 candle power, showing that electric light by storage batteries cost 52 per cent less than oil and 69 per cent less than gas light of the same candle power.

The battery, after having been in daily use for more than three years, proving itself eminently successful under the ill treatment and hard usage to which all railway apparatus is necessarily subjected, Mr. Silvey turned his attention to the storage battery as applied to street car traction.

The American Car Company, of St. Louis, built one of its finest 16 foot car bodies specially for the work, provision being made for placing batteries in iron trays and sliding them under the seats through openings at the end of the car.

The motor with which this car is operated has an armature ring 3¾ inches wide by 24 inches diameter, wound with 2,000 turns of No. 14 B. & S. double insulated wire weighing about 40 pounds; the entire machine complete weighs 1,350 pounds and develops forty horse power. The entire equipment of motor, together with all gears, gear cases, etc., weighed less than 2,000 pounds.

The vital part of the system is the battery, as upon its proper performance the economy of the system largely depends. Low internal resistance must be assured before it is possible to operate without regulating devices, which in all cases are absorbers of energy, and, in a sense, more or less responsible for lack of economy.

The aim of the constructor of this battery has not been to push the efficiency of the apparatus to the utmost limit, making it very light in weight, but rather to make an apparatus capable of withstanding almost any amount of hard usage, and at the same time a battery that could be depended upon whenever needed, and one which if handled with any degree of care at all would always do its duty. It is believed that all this has been fully accomplished, inasmuch as, although the battery has been doing constant service operating the street car for the last nine months, no such thing as a short circuit or buckled plate in the cells has ever occurred from ny cause. Cells having a rated capacity of 30 amperes discharge have frequently been entirely discharged at the rate of 120 amperes and charged at the rate of 100 amperes without doing any harm, either in losing the active oxide or buckling the plates. These extreme charges are of frequent occurrence, as the batteries are charged in three hours and discharged every three and one-half hours during the day, two sets of batteries being employed, one operating the car while the other is being charged.

The battery plate proper consists of an inoxidizable alloyed lead grating, 5 by 7 inches square and about ⅛ inch thick, twenty-one of which constitute a complete battery cell. The perforations in the grid are filled with superficially oxidized particles of metallic lead and oxide of lead, after which they are subjected to a pickling process which hardens the fine particles into a firm coherent mass almost as hard as a rock, and by which it becomes firmly fixed into the holes and forms a surface layer over the entire plate. The plates are now taken and assembled in proper number to constitute a complete battery, there being one more negative than positive plate, as, for instance, eleven negative and ten positive battery plates. The plates are clamped together by means of a lead screw passing through the hole in the plate, nuts being placed between the plates and firmly screwed down, whereby good metallic contact is made, after which they are all welded on the surface and all soldering avoided. In case it ever becomes desirable to take the cell apart, it is easily done by removing these nuts, which by turning break the welded parts. The filling for the battery plates is chemically pure lead, and has been found in practice to give a useful working output of about 20 per cent greater efficiency than is possible with batteries employing a mechanically filled plate of lead oxide alone.

Between the sets of plates in the Silvey battery there is placed a sheet of a porous separating material, the edges of which are saturated with a preservative compound, and which has been treated with acids and alkalies until it becomes practically indestructible in the electrolyte and capable of absorbing about fifty times its own weight of the acids used in the battery. The latter, in fact, becomes nearly a dry cell, or in other words, there is very little free liquid to become spilled. Should the rubber cell ever become broken, the liquid held in suspension in the bibulous separating material is sufficient to operate the car properly during a trip.

In the operation of the car 108 cells of battery are employed, each cell weighing 27 pounds, making a total weight of batteries of about 3,000 pounds, which practice has demonstrated will, in everyday service, operate the car about thirty miles at each charge, running at full speed, which of course will exhaust the cells more rapidly than to run at more moderate speeds. In a test run made in November last the car made a round trip over the Third Street road in Dayton, Ohio, in 35 minutes, the distance being 9 miles. This included several complete stops, besides climbing two hills, each about 1,500 feet long and 4½ per cent grade, crossing 16 railroad tracks and a bridge 500 feet long, so that it is evident the car can easily make 20 to 25 miles an hour, if desired. The car has a controller on each platform containing a reversing switch and three complete changes of electrical circuits, by means of which three speeds of the car are produced.

The car, up to March 23, 1894, has made 6,200 car miles, and neither the batteries nor the motor have ever required a single cent for repairs; in fact, no additions have thus far been made to them except a new set of carbon brushes. The total expense of every kind has been $2.50, all of which was applied to the trucks. With such a record, which is believed to be without a parallel, it is thought that this system has no equal, and that a car can easily be operated at a cost not to exceed 8 cents per car mile.

The Colored American as a Soldier.

Rev. T. G. Steward, Chaplain 25th Infantry, U. S. A., in an article in the last number of the *United Service Magazine* says: Among the military matters coming regularly before the Fifty-second Congress was a proposition to reorganize the artillery and infantry arms of the service.

Had the changes sought in this proposition been secured, the field of the colored man in the army would have been considerably enlarged, and the number of colored men in the service thereby have been increased.

Hitherto there have been four regiments in the service—to wit, the Ninth and Tenth Cavalry and the Twenty-fourth and Twenty-fifth Infantry—of which, according to the law creating them, the enlisted men have been colored men. It is now proposed to confer authority on the President to direct, at his discretion, the enlistment of batteries of colored men to serve in any or all of the regiments of artillery as well.

This movement would indicate that the colored soldier, who won such favorable recognition during the closing period of the civil war, has been able to maintain the same honorable standing during the long period of exacting frontier service which has followed.

These colored regiments have passed all this time, with but little exception, in places far away from popular view, and amid dangers as great and hardships as severe as have been shared by any part of the army. In this dull and trying service they have been carefully weighed in the balances of usefulness, and the general testimony of those whose words are entitled to special weight is that they have not been found wanting. In encounters with robbers and Indians they have manifested both skill and bravery; so that out of ninety-three medals and certificates won for gallantry by the enlisted strength of the army up to 1892, twelve were won by colored men, which is one third more than their proportion.

Generally quite as hardy as white troops, their record in the surgeon-general's report for 1892 presents the two following noteworthy facts: The death rate among the white troops was 8·16 to the one thousand; among the colored troops, 7·11 to the one thousand. The admissions to the hospitals for alcoholism among white troops were 44·91 to the one thousand; among colored troops, 4·36 to the one thousand. Twelve years' experience by the Twenty-fifth Infantry, and a very hard winter's experience by the Tenth Cavalry, in the department of Dakota, prove beyond question that colored troops can stand the cold as well as other troops; and if well cared for, they are as well contented when the mercury is twenty or thirty below as when in "the land of cotton."

The Synthesis of Ammonia.

In June and November, 1893, Mr. P. R. Lambilly, of Nantes, patented a process for the production of ammonia by synthesis—a problem that has been pursued for a long time and the importance of which is classic. According to the *Moniteur de Quesneville*, the operation is effected as follows:

The process is based upon the reciprocal action of nitrogen, hydrogen, and aqueous vapor in the presence of substances that act by contact. It is characterized by the addition to the gaseous mixture of carbonic acid, which fixes the ammonia formed in the state of bicarbonate or formate.

As we know, ammonia, or hydrate of ammonium, has the property of forming salts with acids or the anhydrides of acids. It behaves in this case as an energetic base.

Through their formation from the elements, the bicarbonate and formate of ammonia disengage a quantity of heat that exceeds by more than 20 calories that which is produced by the union of the elements for the formation of hydrate of ammonium. According to Mr. Lambilly, this circumstance shows the advantage that may be derived from the direct preparation of these salts by means of free nitrogen. Such preparation, moreover, is realizable, since it suffices to produce the ammonia in the presence of oxide of carbon and carbonic acid or anhydrides of formic and carbonic acid. The reactions to be effected are the following:

$$Az + H^3 + CO^2 + H^2O = CO <^{OAz\,H^4}_{OH}$$

$$Az + H^3 + CO^2 + H^2O = H\,CO^2\,Az\,H^4$$

Or else:

$$2Az + 8H + 2CO^2 + H^2O = CO <^{OAz\,H^4}_{OH} \Big\} + H\,CO^2AzH^4$$

In fact, such reactions occur when the constituents, nitrogen, aqueous vapor, and water gas, of a mixture of hydrogen, CO and CO^2, are brought into contact with certain porous substances, such as pumice stone, charcoal, and boneblack, especially when they are platinized. They are produced even at a low temperature in the presence of spongy platinum or platinum black. They are more active, however, at temperatures near the points of dissociation of the salts, that is to say, toward 40-60° C. for the bicarbonate and 80-160° C. for the formate.

The gaseous mixtures pass into pipes filled with porous bodies heated to the temperatures indicated. Upon their entrance into the pipes they are saturated with aqueous vapor, either by the injection of a current of steam or by their passage into water heated to the proper temperature. Upon making their exit from the apparatus the gases pass into the water, wherein the ammoniacal salts formed dissolve. The gases that have not acted are collected and are sent back into the apparatus for a second time.

The solution of the salts is distilled over lime. If formate of ammonia is found therein, there is obtained, as an accessory product, formate of ammonia, which might serve for the preparation of formic acid or of salts.

It belongs to special industrial chemists to estimate the value of this process of synthetical fixation of nitrogen and to reduce it, outside of any pure scientific conception, to its just proportions.—*Le Genie Civil.*

Photographic Notes.

Eliminating the Yellow Color from Negatives.—A method outlined by Mr. A. Cowan at the London and Provincial Association, as reported in the *British Journal of Photography*, consists in first bleaching the negative with a weak solution of perchloride of iron and then in redeveloping with the ferrous oxalate developer. This changes the film to a dark black and produces any desired density. If the yellow color extends over the whole surface of the film, the plan does not answer as well, as a veil will redevelop.

Yellowness in dry plate negatives is due to insufficient fixing or insufficient washing after the negative has been fixed, and no remedy for it at all satisfactory has been devised. It cannot be removed by the ordinary clearing solutions recommended for eliminating pyro stains.