is to say, if one impregnates with it fresh *bouillon*, the latter is completely sterile. Up to that time life exists in the vase exposed to air and heat. If we examine the virulence of the culture at the end of two days, four days, six days, eight days, etc., it will be found that long before the death of the culture the microbe has lost all virulence, although still cultivable. Before this period it is found that the culture presents a series of attenuated virulences. Everything is similar to what happens in respect to the microbe in chicken cholera. Besides, each of these conditions of attenuated virulence may be reproduced by culture; in fact, since the charbon does not operate a second time (*ne récidive pas*), each of our attenuated anthracoid microbes constitutes for the superior microbe a vaccine—that is to say, a virus capable of producing a milder disease. Here, then, we have a method of preparing the vaccine of splenic fever. You will see presently the practical importance of this result, but what interests us more particularly is to observe that we have here a proof that we are in possession of a general method of preparing virus vaccine based upon the action of the oxygen and the air—that is to say, of a cosmic force existing everywhere on the surface of the globe.

"I regret to be unable, from want of time, to show you that all these attenuated forms of virus may very easily, by a physiological artifice, be made to recover their original maximum virulence. The method I have just explained of obtaining the vaccine of splenic fever was no sooner made known than it was very extensively employed to prevent the splenic affection. In France we lose every year, by splenic fever, animals of the value of twenty million francs. I was asked to give a public demonstration of the results already mentioned. This experiment I may relate in a few words. Fifty sheep were placed at my disposition, of which twenty-five were vaccinated. A fortnight afterward the fifty sheep were inoculated with the most virulent anthracoid microbe. The twenty-five vaccinated sheep resisted the infection; the twenty-five unvaccinated died of splenic fever within fifty hours. Since that time my energies have been taxed to meet the demands of farmers for supplies of this vaccine. In the space of fifteen days we have vaccinated in the departments surrounding Paris more than twenty thousand sheep, and a large number of cattle and horses. If I were not pressed for time I would bring to your notice two other kinds of virus attenuated by similar means. These experiments will be communicated by-and-by to the public. I cannot conclude, gentlemen, without expressing the great pleasure I feel at the thought that it is as a member of an international medical congress assembled in England that I make known the most recent results of vaccination upon a disease more terrible, perhaps, for domestic animals than small-pox is for man. I have given to vaccination an extension which science, I hope, will accept as a homage paid to the merit and to the immense services rendered by one of the greatest men of England, Jenner. What a pleasure for me to do honor to this immortal name in this noble and hospitable city of London!"

FROM a privately issued report on silk cultivation in the Chinese province of Kwangtung, we learn that in the Pakhoi district, on the southern seaboard, wild silkworms are found which feed on the camphor tree, and their silk is utilized in a singular manner. When the caterpillar has attained its full size, and is about to enter the *pupa* state, it is cut open and the silk extracted in a form much resembling catgut. This substance, having undergone a process of hardening, makes excellent fish line, and is generally used for that purpose in the Pakhoi district.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

To the Editor of "SCIENCE."

Mr. Samuel J. Wallace, commenting on my paper on "The Use of Water as a Fuel" ("SCIENCE," Vol. II., p. 321), in an interesting communication to you ("SCIENCE," Vol. II., p. 373), suggests an inadvertancy on my part in "not more clearly distinguishing between the degrees of temperature at which the transfer of oxygen takes place from the hydrogen of the water to the carbon set free by the dissociation of the naphtha and the number of heat units set free or absorbed by such transfer, which is a very different thing."

To this I would state in reply that I have purposely refrained from an elaborate calculation of the thermal effects in heat units for several reasons. Of these I shall detail but a few of the more important at present.

In the first place, my intention was to give the scientific rationale of the chemical processes involved in the generation of the tremendous heat produced by the Holland retort with so insignificant an amount of naphtha; and, furthermore, I wanted to show that the application of the principle of the correlation of forces and conservation of energy to this new and original process of combustion has been undertaken heretofore on an erroneous assumption; lastly, I intended to prove, in the shortest and clearest possible manner, what a proportion of heat was gained, and in what manner—viz., by the dissociation of steam in the presence and by the agency of the carbon contained in the naphtha.

For these and other reasons, I avoided long explanations and calculations of other points, such as, for instance, the "dissociation of the naphtha," as Mr. Wallace puts it, and the figuring up of the heat units generated by the several elements on combustion. In order to re-affirm my position, which is, on most points, not that assumed by Mr. Wallace, I may be allowed to offer the following remarks:

It is self-evident that the carbon of the naphtha, in order to act independently, must first be set free; this is accomplished by the heating of the naphtha, in its chamber of the retort, up to the point of gasification. On meeting the steam in the manifold, the carbon of the naphtha leaves its hydrogen and forthwith unites with the oxygen of the watery vapor, forming *either* carbonic oxide *or* carbonic acid, according to the amount of steam introduced.

Thus there is certainly a decomposition of the naphtha into its elements, as Mr. Wallace intimates; but by far the most important process is the *dissociation of the watery vapor* which Mr. Wallace refuses to recognize, insisting, as he does, that there is only a *transfer* of the oxygen from the hydrogen of the steam to the carbon of the naphtha. How this is possible, without the previous dissociation of the steam, I am unable to understand. Mr. Wallace furnishes, indeed, the best argument against his own statement, by mentioning the well-known fact that the carbon in the naphtha is very loosely held by its hydrogen. But it is also a well-known fact that the oxygen of the steam is very tenaciously held by its hydrogen, so much so that it was considered impossible to separate, *to dissociate*, them by heat for a long time. Not until the late Henri St. Clair Deville * devised an appa-

* It is with profound grief that the announcement of the great chemist's death has been received everywhere. At his funeral (July 5th) M. Pasteur made an eloquent speech. The London *Chemical News* has an obituary in which occurs the following passage: "His highest achievement, from a strictly scientific point of view, was the establishment of the laws of dissociation. Previously, decomposition was regarded as a simple phenomenon, effected and completed, in the case of every substance, at a fixed temperature. Deville showed that in some cases it is effected within certain limits of temperature, being arrested at a given heat by the equilibrium established between the decomposing body and the product of decomposition."

ratus *for this purpose* was this dissociation accomplished by heat alone.

The reason for this state of things is apparent. Hydrogen in uniting with oxygen to form water develops the greatest amount of heat, a greater amount, in fact, than an equal weight of any other known element. And just here I would ask Mr. Wallace which authority has stated that the "absolute heat of carbon and hydrogen are almost exactly equal in complete burning." On the contrary, all authorities agree, and all investigators have established beyond doubt the fact, that hydrogen develops *more than four times as much heat* on combustion than does an equal weight of carbon. The figures at present universally accepted as a standard are those determined by Favre and Silberman, during their carefully conducted and numerous experiments. According to them—

1 grain of hydrogen develops 34,462 units of heat.
1 grain of carbon " 8,080 units of heat.

on complete combustion.

This great advantage in the heat-producing power of hydrogen is the principal reason why scientists have constantly striven to substitute this element for carbon, which is now universally used as fuel. But until lately only this was thought impracticable, because it was believed that the same amount of heat was necessary to obtain the hydrogen by the dissociation of water, which would ultimately be obtained by the combustion of said hydrogen. And even the processes of Strong and others for the generation of so-called 'water-gas' have not changed this erroneous view. For, the advantages arrived at by them were ascribed rather to various extraneous causes* than to the one principal cause, *i. e.*, the dissociation of steam by the chemical affinity of carbon, and the consequent generation of a not inconsiderable amount of hydrogen.

This very same line of argument has been followed in the discussions about the Holland process, and the principal aim of my paper was to controvert it, and to show that it is *not heat, but chemical affinity*, which does by far the greatest part of the work of dissociation. I was enabled to do so on the basis of Dahlerus' experiments, which have proved conclusively that carbon will dissociate water at 400° C, instead of 8000° C, which is Deville's figure for the dissociation-temperature of water in the absence of any other element.†

From the foregoing the readers of "SCIENCE" will perceive that the enormous gain obtained by actual experiment with the Holland locomotive is satisfactorily explained on scientific grounds.

All the further argumentation of Mr. Wallace covers the earlier water-gas processes of Lowe, Strong and others; they generate their gaseous fuel in a separate contrivance (the generator) and afterward burn it. For this reason they want to accomplish only the first stage of carbon, combustion water-gas, consisting of hydrogen and carbonic oxide. In the process under consideration, however, the retort which prepares the fuel, *i. e.*, gasifies the naphtha and the water, is placed just where the heating is to take place. All the heat, therefore, that is developed by the carbon combustion is utilized, as is also all the heat which is developed by the dissociated hydrogen burning up with atmospheric oxygen.

Indeed, this process is the only one which comes pretty near to fulfill all the requirements of an ideal method. These are;

1. Gaseous condition of the fuel.
2. Complete combustion (no smoke, no ashes).
3. Full effects of the caloric energy developed.
4. Regulation of the draught-air, so as to admit the least amount of atmospheric air practicable.
5. Greatest possible percentage of oxygen in atmosphere of combustion. (The oxygen derived from the dissociation of the steam being employed for the combustion of carbon, the necessary draught-air is thereby materially reduced and thus the percentage of oxygen increased).
6. Universal adaptibility (kitchen and parlor stoves, fire places, stationary and other boilers, locomotives and ocean steamers can be accommodated with it, and illuminating gas is prepared automatically by an additional chamber in the retort).
7. Simplicity of apparatus. (May be managed by the turning of a few faucets.)
8. Cheapness of the fuel employed. (Water is certainly to be obtained everywhere at small expense, while the price of naphtha is only three cents a gallon if bought by the single barrel.)
9. Fuel used of the greatest heating capacity, with each atom of Carbon burned, there are burned at the same time *four* atoms of Hydrogen, thus:

$$\underset{\text{(Naphtha.)}}{C_2H_4} + \underset{\text{(Water.)}}{4\,HO} = 2\,(CO_2) + 8\,H.$$

The eight Hydrogen are burned with atmospheric Oxygen.

Crude oil *i. e.* petroleum that has undergone one distillation, to free it from its mineral and waxy ingredients, may be used, but would be much dearer. Naphtha, it may be said in conclusion, is not one of the distillation products, as might be inferred from the name: It is the unused residue from all the various distillation-processes to which petroleum is subjected. *It is a waste product* and therefore cheaper than anything else.

It is obtained in this wise:

The crude oil as it is received from the stills of the petroleum regions is subjected to twelve successive distillations, and the following products result:

Cymogene.
Rhigolene.
Gasolene.
C. Naphtha.
B. Naphtha.
A. Naphtha.
Benzine.
Kerosene.
Mineral Sperm Oil.
Lubricating Oil.
Paraffin.

Of these only the last four are completely used in the arts and for illuminating purposes. The unused residue of all the others is thrown back into the residue remaining from the last distillation. The quality of the mixture called Naphtha, and used in the Holland process is therefore not always the same, but this does not at all alter its value as a fuel, as it does not alter the main features of this process, as they have been explained in our remarks.

GEO. W. RACHEL, M. D.

* Some of these are: gasification of the fuel, substitution of the second for the first stage of carbon—combustion, reduction of the amount of draft-air, etc.

† The combustion- (and dissociation-) temperature may be found by calculation from the thermal effect and the specific heat of the product (*i. e.*, water) in the following manner, according to MOHR (Mech. Theorie d. chem. Affin., p. 102):

If one part of hydrogen burns up with eight parts of oxygen, forming nine parts of water, 34462 units of heat are generated which are contained in the watery vapor thus formed. If the specific heat of steam would be the same as that of water, the actual temperature of these nine parts of water would be:

$$\frac{34462}{9} = 38290° \text{ C.}$$

Since the specific heat of steam is, however: .475, the actual temperature of the nine parts of watery vapor is:

$$\frac{3829}{.475} = 8061° \text{ C.}$$

For this reason 8000° C has been assumed as the dissociation-temperature of watery vapor.

King's Cross Station, Great Northern Railway, is now lighted by means of electricity, a beginning having been made last week by means of the Crompton system. There are 12 Crompton lamps within the station, six being placed over the arrival, and a similar number over the departure platform. Two other lamps of larger size are placed outside the station building. The interior area lighted consists of two bays, each 880 feet long and 105 feet wide, and 72 feet high, as well as the cab-rank adjoining the arrival platform, which is 40 feet wide. The total area lighted is 220,000 square feet, giving an area of 18,133 square feet, or nearly half an acre, to each lamp. The lamps are suspended at a height of 30 feet from the platform level, and are arranged on four circuits, the light of each lamp being computed as equivalent to 4000 candles. Any unpleasantness from the intensity of the light is obviated by the use of semi-transparent glass in the lower portion of the lanterns. The two exterior lights are estimated at 6000 candles each, are placed at an altitude of 70 feet, the lanterns being of clear glass. The current is supplied by means of five Burgin dynamo-electric machines, which are driven by a semiportable engine by Messrs. Marshall, Sons & Co., of Gainsborough, working up to 35-horse power.

THE death of John Duncan, the Alford, England, botanist, is announced as having taken place last week in his 85th year. The deceased adopted the occupation of a weaver by trade, but devoted all his spare time to the study of botany. His splendid collection of plants he handed over to Aberdeen University a year ago, but he has lived barely six months to enjoy the fund which public recognition of his merits placed at his disposal in his declining years. The story of John Duncan's life is to be told by Mr. Jolly, himself an enthusiastic botanist.

Various attempts have been made to explain the tails of comets. A recent one by M. Picart is as follows: The Sun, the stars, nebulæ and comets, are composed not only of ponderable matter in the gaseous state, but of imponderable matter, the luminous ether, revealed, in the case of the sun by the zodiacal light, and in that of nebulæ, by their irregular forms contrary to gravitation. A comet far from the sun, appears in spheroidal form, due to gravitation of its ponderable matter (its luminous ether being then invisible because of distance and feeble light). But on nearing the sun, the luminous ether of this body repels that of the comet (this being a characteristic property of the ether) so forming the tail. The form and direction of the tail are thus quite independent of gravitation; and the enormous velocity ceases to be a difficulty, as it is if the matter of the tail be thought ponderable. M. Lamey has observed that the solar light, being unable completely to penetrate the comet's tail, illumines only the left part, producing a true cometary phase.

THE assimilation of nitrogen by plants has, of late, been carefully studied by Signor Lamattina, of Rome, who arrives at the following results: Plants absolutely require to assimilate nitrogen, and they obtain it in three forms: (1) In the nitrates of the ground; (2) In the ammonia of the air; (3) In the State of protoxide in the atmosphere. The nitrogen in the state of nitrates, absorbed by the roots, is for transport and diffusion of mineral substances, principally potash, in the leaves, helping to form chlorophyll and hydrocarbons. The nitrogen absorbed in the form of ammonia by respiration, serves for formation of albuminoids, fibrine, etc. The nitrogen absorbed in the state of protoxide, appears to serve as complement of the food of the plant, acting both as corrective, by neutralising the basis in excess, and helping in the formation of alkaloids.

METEOROLOGICAL REPORT FOR NEW YORK CITY FOR THE WEEK ENDING AUG. 27, 1881.

Latitude 40° 45′ 58″ N.; Longitude 73° 57′ 58″ W.; height of instruments above the ground, 53 feet; above the sea, 97 feet; by self-recording instruments.

AUGUST.	BAROMETER. Mean for the Day.	Maximum.		Minimum.		THERMOMETERS. Mean.		Maximum.				Minimum.				Maxi'm
	Reduced to Freezing.	Reduced to Freezing.	Time.	Reduced to Freezing.	Time.	Dry Bulb.	Wet Bulb.	Dry Bulb.	Time.	Wet Bulb.	Time.	Dry Bulb.	Time.	Wet Bulb.	Time.	In Sun.
Sunday, 21	29.628	29.678	12 p. m.	29.598	5 p. m.	77.0	69.0	85	5 p. m.	73	5 p. m.	68	5 a. m.	65	5 a. m.	144.
Monday, 22	29.802	29.896	12 p. m.	29.678	0 a. m.	74.0	66.0	81	3 p. m.	69	2 p. m.	67	12 p. m.	62	12 p. m.	139.
Tuesday, 23	29.979	30.046	12 p. m.	29.896	0 a. m.	72.3	64.0	83	5 p. m.	69	2 p. m.	61	6 a. m.	59	6 a. m.	140.
Wednesday, 24	30.138	30.196	12 p. m.	30 046	0 a. m.	73.3	66.6	82	2 p. m.	73	2 p. m.	63	5 a. m.	60	6 a. m.	141.
Thursday, 25	30.200	30.212	9 a. m.	30.168	6 p. m.	70.3	64.6	76	3 p. m.	67	3 p. m.	65	3 a. m.	62	3 a. m.	131.
Friday, 26	30.151	30.198	0 a. m.	30.110	4 p. m.	71.7	67.0	82	3 p. m.	73	3 p. m.	63	7 a. m.	62	8 a. m.	134.
Saturday, 27	30.114	30.156	9 a. m.	30.072	6 p. m.	72.0	66.7	78	2 p. m.	70	2 p. m.	66	6 a. m.	64	6 a. m.	128.

Mean for the week .... 30.002 inches.
Maximum for the week at 9 a. m., August 25th .... 30.212 "
Minimum " at 5 p. m., August 21st .... 29.598 "
Range .... .614 "

Dry. Wet.
Mean for the week .... 72.9 degrees .... 66.2 degrees.
Maximum for the week, at 5 pm. 21st 85. " at 5 pm 21st, 73. "
Minimum " " 6 am. 23d 61. " at 6 am 23d, 59. "
Range " " .... 24. " .... 14. "

AUGUST.	WIND. Direction.			Velocity in Miles.	Force in lbs. per sqr. feet.		HYGROMETER. Force of Vapor.			Relative Humidity.			CLOUDS. Clear, 0 Overcast, 10			RAIN AND SNOW. Depth of Rain and Snow in Inches.				OZONE.
	7 a. m.	2 p. m.	9 p. m.	Distance for the Day.	Max.	Time.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	Time of Beginning.	Time of Ending.	Duration. h. m.	Amount of water	
Sunday, 21	n.	n. n. e.	w. n.w.	123	3¼	11 am	.537	.623	.652	71	53	73	3cir.cu.s	3 cu. s.	10	11 p m	11½ p m	0.30	.01	3
Monday, 22	n. w.	n. w.	n. n. w.	153	3	3.30 pm	.516	.547	.537	70	52	71	0	3 cu.	0	-----	-----	-----	--	7
Tuesday, 23	n. w.	n. w.	n. n. w.	155	2¼	4.40 pm	.433	.547	.489	72	52	62	0	3 cu.	0	-----	-----	-----	--	1
Wednesday, 24	n. n. e.	n. e.	s. e.	121	4	1.30 pm	.462	.663	.564	65	63	79	0	1 cir. cu.	0	-----	-----	-----	--	0
Thursday, 25	s. s. e.	s.	s. s. w.	140	2¼	3.20 pm	.509	.554	.543	74	64	79	8 cu.	0	0	-----	-----	-----	--	0
Friday, 26	w. s. w.	s.	s. s. w.	150	2	3.00 pm	.576	.624	.608	100	59	80	10	1 cu.	0	-----	-----	-----	--	0
Saturday, 27	s. w.	s.	s. s. w.	140	2	4.40 pm	.543	.625	.586	79	65	80	8 cu.	1 cu.	0	-----	-----	-----	--	0

Distance traveled during the week .... 982 miles.
Maximum force .... 4 lbs.

Total amount of water for the week .... .01 inch.
Duration of rain .... 00 hours, 30 minutes.

DANIEL DRAPER, Ph. D.

Director Meteorological Observatory of the Department of Public Parks, New York.