as in fig. 1, represented by dotted lines. D and E, are partitions which direct the draught through the tubes in the following manner. Let F represent the furnace, and C a part of the flue into which the tubes A A, open, the draught being arrested by the partition D, will pass through A A, into the flue H, and being arrested by the partition E, will return through the tubes B B, then pass those marked C C, into the flue I, leading into a smoke pipe, or chimney; J, may represent the water line, K, the steam chamber, and L, the steam pipe.

Although I have mentioned a certain number of tubes, and have said that in the boiler which I have tried, the heated air is made to pass through the water three several times, it is manifest that the same operation may be repeated as frequently as it shall be found advantageous so to do. The number of tubes also, may be varied, and they may be placed in single rows, or otherwise, without altering the principle of action.

I have not mentioned the safety valves, cocks, or other general appendages to steam boilers, as in these I do not profess to have made any improvement; nor have I described any particular manner of securing the tubes, this being well known to engineers.

A boiler thus made, is recommended by its simplicity and economy, where it is desirable to generate a large quantity of steam under a moderate pressure, as for the purposes of heating and drying in various manufacturing processes. What I claim as my invention in it is the general combination and arrangement of the parts by which the draught from the fire is made to pass repeatedly through the water, as herein set forth, whether made in the exact form represented, or in any other which is substantially the same in its construction and operation.

JOHN AMES.

Progress of Physical Science.

On a new Force acting in the Formation of Organic Compounds. By M. BERZELIUS. (*Jahrbuch de Schumacher*, for 1836).

When new compounds are produced in inorganic nature as the result of the reaction of different bodies, it is in consequence of a mutual tendency of those bodies to satisfy the laws of their affinity in a more complete manner. First, the substances possessing dominant affinities enter into combination, and then those of feeble affinities which were excluded from the first combination. Before the year 1800, the existence, in these phenomena, of any other determining cause than the degree of affinity, heat, and, in some cases, light, was scarcely suspected. The influence of electricity was then discovered, and we soon saw ourselves in danger of confounding the electrical with the chemical relations of bodies, and of considering their affinities only as the manifestation of a strong electrical contrast, increased by light and heat. This system offered no other means of explaining the origin of a new compound, than by the supposition, that, by the approximation of bodies which are present, their electrical states become neutralized in a more perfect manner.

Setting off from these ideas, deduced from the effects which occur in inorganic nature, and studying the chemical re-actions presented by organized bodies, we perceived that in the organs of the latter, substances the

most various were elaborated, while the brute matter, whence they proceeded, consisted, in general, of but one liquid, circulating in vessels with more or less velocity. The vessels of the animal body, for example, pump blood from their origin without interruption, and nevertheless, secrete milk, bile, urine, &c. at their extremities, without admitting any other liquid capable of producing, by double affinity, any decomposition whatever. A fact here evidently occurs, which the study of inorganic nature was then unable to explain.

At this period M. Kirchhoff observed that starch dissolved in diluted acid, became converted, at a certain temperature, first into gum, and afterwards into grape-sugar. In conformity with the principles then received with regard to effects of this kind, an endeavour was made to ascertain what the acid had removed from the starch to reduce it into sugar; but no gas had been disengaged, the acid re-appearing by means of the alkalies in its primitive quantity, had not been combined, and the liquid contained only sugar in an equal, or even a larger, quantity than the starch which had been employed. The cause of this alteration was as problematical as that of the secretions in the organic body. M. Thénard then discovered the peroxide of hydrogen, a liquid, the elements of which are retained in combination by a very weak affinity. The acids do not produce any alteration in it; the alkalies, on the contrary, produce in it a tendency to decomposition, a species of fermentation, which reproduces water, in consequence of a disengagement of oxygen. But the most interesting circumstance, is, that the same effect takes place from the action of different solid bodies insoluble in water, organic as well as inorganic; for example, from the presence of peroxide of manganese, of silver, platinum, and also the fibrin of animal blood. The body which determines the decomposition does not undergo any alteration, it does not act as an element of a new compound, but by virtue of a peculiar force inherent in its mass, the existence of which, though unknown in its essence, is demonstrated by its effects. Shortly before M. Thénard, Sir H. Davy remarked another phenomenon, the analogy of which with the one just described, was not immediately perceived. He had proved that platinum, heated to a certain degree, and brought into contact with a mixture of the vapour of alcohol, or ether, and atmospheric air, possessed the power of determining and sustaining the combination of these bodies, while gold and silver were devoid of this property. Soon after, Mr. E. Davy discovered a preparation of platinum in a state of very great mechanical division, having, at ordinary temperatures, and after having been moistened with alcohol, the property of becoming incandescent by the combustion of alcohol, altogether in converting it by oxidation, into acetic acid. Then followed the discovery of Döbereiner, the most important of all. He proved that it is the property of spongy platinum to inflame, spontaneously, a current of hydrogen gas projected in the air; a phenomenon which the researches of M. M. Thénard and Dulong proved is produced by several other bodies, simple as well as compound: with this restriction, however, that while platinum, iridium, and some other platinal metals, act at temperatures below zero, other bodies, such as gold, and more especially silver, require a much higher temperature, and glass a heat even of above 300°. Thus what was at first considered as an exceptive mode of action, appeared to be a general property, though variously graduated, of all bodies, and from the application of which, advantage might be derived. We know, for example, that in the act of fermentation, in the conversion of sugar into alcohol and carbonic acid, the

action exercised by the insoluble substance named leaven, and which may be replaced, though with less success, by animal fibrin, albumen, and caseous substances, &c., cannot be explained by any chemical reaction of the affinities of the sugar and the leaven, and that no effect in inorganic nature approaches it so nearly as the action of platinum, silver, or fibrin in the decomposition of the peroxide of hydrogen into oxygen and water. It was natural here to suppose an analogous mode of action. The conversion of starch into sugar, by means of sulphuric acid, had not yet been co-ordinated with the preceding facts; the discovery, however, of diastase (announced in the Annual Report for 1833), a substance acting upon starch in an analogous manner, only with more energy, directed attention to this analogy, which was definitively proved by the ingenious researches of M. Mitscherlich upon the formation of ether. Among the numerous theories upon the formation of ethers, one, we know, makes the property of sulphuric acid to convert alcohol into ether, to depend upon its power of absorbing water, granting, that the alcohol, considered as a compound of one atom of etherine (C^4H^3), and of two atoms of water, is reduced into ether, by ceding the half of its water to the acid. This theory, equally simple and ingenious, was in perfect agreement with our knowledge of the reaction of the affinities of bodies; it did not, however, explain why other bodies, not acids, having equal avidity for water, could not be employed in the same manner; why soda, potash, chloride of potassium, anhydrous lime, &c., if the transformation really depended only upon an affinity for water, did not equally produce ether. The researches of M. Mitscherlich proved that sulphuric acid, sufficiently diluted, and taken at such a temperature that the refrigeration produced by the addition of the alcohol, compensated for the heating which arose from the mixture, decomposed the alcohol into ether and water, which, because the temperature exceeded the temperature of ebullition of water, were both separated by distillation from the mass, and, as soon as the condensation was complete, presented a mixture of the same weight as that of the alcohol employed. The manner of performing this experiment, as well as the fact of the distillation of water conjointly with alcohol, was, it is true, known before M. Mitscherlich, but to him belongs the merit of having predicted its consequences. In fact, he proved that at this temperature, sulphuric acid must act upon alcohol by virtue of the same force which determines the action of the alkalies upon oxygenated water, since the water being entirely separated from the mixture, did not obey an affinity for the acid; whence he concluded, that the action of sulphuric acid and diastase upon starch, from which resulted the sugar, must be of the same nature.

It is then proved that many substances, simple or compound, solid or in solution, have the property of exercising an influence upon compound bodies essentially distinct from chemical affinity, an influence which consists in the production of a displacement, and a different arrangement, of their elements, without participating in it directly and necessarily, except in a few special cases. Certainly a force such as this, capable of producing chemical reactions in inorganic nature, as well as in organized bodies, though at present too little understood to be well explained, must exercise a more important function in nature than has hitherto been supposed. In defining it as a new force, I am far from wishing to deny that a certain connexion exists between it and the electro-chemical relations of matter. I am, on the contrary, strongly disposed to recognize in it a decided manifestation of these relations; nevertheless, till we have penetrated into the

real nature of this force, it will be more simple in our future researches to consider it as independent, and to give it, for facility of recognition, a name peculiar to itself. According to an etymology well known in chemistry, I shall consequently name it the CATALYTIC FORCE of bodies, and the decomposition which it determines *catalysis*, in the same manner as the separation of the elements of a compound, by means of the usual chemical affinities, is called *analysis*. This force may be defined to be *a power of bodies to bring into activity, by their simple presence, and without participating in it chemically, certain affinities, which at that temperature would remain inactive, so as to determine, in consequence of a new distribution of the elements of the compound, a new state of perfect chemical neutralization*. As this force acts in general in a manner analogous to heat, it may be inquired whether being variously graduated, sometimes by employing differently the same catalytic body, sometimes by the introduction of various catalytic bodies in the same liquid, it will cause, as is often observed in the action of heat at different temperatures, different catalytic products,—whether the catalytic force of a body can be exerted over a large number of compounds, or whether, as our experiments appear to indicate, only over certain bodies, to the exception of certain other bodies? But in the present state of our knowledge it is impossible to decide these questions, and many others that might be proposed upon the subject: their solution must depend on the results of future investigations. It is enough, for the present, to have shown, by a sufficient number of examples, the existence of this force, which, defined as it has been, diffuses a new light over the chemical reactions of organized bodies. We shall cite but one example. There is an accumulation of diastase around the eye of the potatoe, which is not found in the tubercle or in the developed germ; we perceive in this point a centre of catalytic action, at which the insoluble starch of the tubercle is converted into gum and sugar, and this part of the potatoe will become the secreting organ for the soluble substances, which are to form the juices of the growing germ. It is not probable that the action mentioned is the only one of its kind in vegetable life; on the contrary, it may be presumed, that in vegetables, as well as in the animal body, a thousand catalytic effects take place between the tissues and the liquids, whence results the great number of different chemical compounds, the production of which, from the same brute matter, which we call blood, or vegetable juices, cannot be explained by any other known cause.—*Bibliothèque Universelle, Nouv. Ser. Tome ii., p. 376.*

A. T.

Rep. Pat. Invent. Aug.

Sixth Meeting of the British Association for the Advancement of Science.

The Annual Sessions of this Association were commenced by a meeting of the General Committee, at Bristol, on Saturday, August 20, and were continued throughout the following week. The arrangement was, that the Sections should meet at eleven o'clock every day during the week, and that the General meetings of the Association should be held at 8 o'clock on the evenings of Monday, Wednesday and Friday. The concluding meeting to take place on Saturday, at an hour fixed by the General Committee. Several public dinners were given, and an ordinary was provided daily, at the Horticultural rooms, for strangers, at 5s. per head. The number of members in attendance exceeded that of any previous meeting,