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NEW YORK, SATURDAY, JULY 24, 1880.

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on's process Beaumont Compressed Air Engine... Liquid Fuels for Steam Engines...... Influence of Piston Speed 378 \$784 \$784 3786 New Vehicle for Common Roads. By TREAT T. PROSSER, 3788

TIBIRICA. Explosion of Wine. By V. WARTHA.

3796

MATTER AS A MODE OF MOTION.

It is a curious circumstance that while from the non-i matter. scientific point of view the unpardonable fault of modern science is its "materialistic tendency," the actual drift of scientific thought is toward eliminating from the scientific idea of matter everything which answers to the popular notion of it. Already science has permanently transferred to the domain of motion all those possibilities of sensation, such as light, heat, electricity, and so on, formerly defined as imponderable matter; and latterly the indications have been very clear that ponderable matter may sooner or later rapidity and thus generating a large quantity of gas. Gunshare the same fate.

This comes out strongly in the discussion awakened by Professor Crookes' discoveries touching the behavior of molecules in high vacua. As our readers are well aware, Professor Crookes claims to have demonstrated an ultra-gaseous or fourth state of matter, as unlike the other three recognized states of matter as they are unlike each other. In answer to a friendly challenge to make good his position, Professor Crookes has reviewed (in a letter to the Secretary of the Royal Society, to be found in full in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT) the accepted views as to the constitution of solids, liquids, and gases, and has added thereto a concise explanation of the ultra-gaseous state and his reasons for holding it worthy of a class by the rapid combination of two gases, or of a vapor and a gas. itself.

Stated with the utmost brevity, a solid is an aggregation comparison with their diameters, since the mass "must be able to bear a reduction of temperature of nearly 300° C. before the amplitude of the molecular excursion would vanish." What would result from the arrest of molecular movement and the actual contact of the molecules is beyond our conception, all we know of matter being based wholly upon our experience of molecular movements.

straining force of gravitation or the resistance of an inclosing vessel, the molecules of a gas fly about in every conceivable direction, with constant collisions with each other and with the vessel's sides. The gaseous state is thus preeminently one dependent on molecular collisions, the mean free path of the molecules, in other words, their flight beof the inclosing vessel.

The fourth state of matter, according to Professor Crookes, of the molecules are few compared with the misses, the free each molecule is allowed to obey its own motions or laws, without interference from collisions with other molecules or with the sides of the inclosing vessel. The same condition prevails when the molecules of a denser gas are so marshaled in their flight that their motion is rectilinear and no collisions occur. Between the third and fourth states there is no sharp line of demarkation, any more than there is be tween the solid and liquid states, or the liquid and gaseous states; they merge insensibly one into the other.

Thus starting from a possible, though in our present state undemonstrable, condition of matter, in which the mole cules are motionless and in contact-a condition, we must re member, in which "matter" would in no way answer to the definition of matter as discovered by our senses-we pass on through stages of increasing molecular freedom and amplitude of motion, until we arrive at a stage of comparative molecular independence and rectilinear flight, limited in our experiments by the necessary walls of our vacuum apparatus. matter and becomes as if it were not. For what is a single free molecule in space? Is it solid, liquid, or gas?

Professor Crookes answers: "Solid it cannot be, because the idea of solidity involves certain properties which are absent in the isolated molecule. In fact, an isolated molecule is an inconceivable entity, whether we try, like New-

molecular movement forms no part of the popular idea of

EXPLOSIVES.

Were the question suddenly proposed to any intelligent person, "What is an explosive?" the chances that he would give a correct answer are indeed small. Our first and usual idea is that an explosive is something which will blow up, making a big noise and doing more or less damage. Generally it is some solid or liquid capable of burning with great powden is a familiar example; the niter furnishes oxygen to burn the sulphur and charcoal, most of the products being gaseous. Bunsen, who made some careful quantitative experiments upon the combustion of gunpowder, found that 1 gramme of sporting powder produced 193 c.c. of gas, while Linck obtained 218 c.c. of gas from 1 gramme of war powder, and as one gramme of powder will occupy less than 1 c.c. of space, the increase of volume is very considerable. But this is not all, for the temperature at the time of explosion is calculated to be about 3,000° C., and gases double their volume whenever the temperature is raised 273°.

Explosions are in but few cases due to the rapid combustion of solids or liquids, but more frequently they consist in

When pure hydrogen and oxygen aremixed in proportion of two volumes of the former to one of the latter, a spark causes of molecules held together by cohesion and oscillating about ; them to unite with explosive violence, although the resulting fixed centers. The movements of the molecules are large in product, at 100° C., occupies but two-thirds as much space of the mixed gases, and at ordinary temperatures it occupies but $\frac{1}{3500}$ as much space. The rapidity with which a flame travels in such a mixture is not less than 100 feet per second. The temperature produced is very high, and at this temperature, of course, the gases occupy a very large space.

Rapid combustion of solids in a fine state of division may exhibit the usual phenomenon of an explosion, as has seve-When the temperature of a solid is raised and the force of ral times occurred in flouring mills, or wherever dust mixed cohesion so far overcome that the molecules lose their fixity with air has been ignited by a spark. The explosion of gasoof position, the second or liquid state of matter obtains. A lene and benzine is of the same nature. The vapor is the further raising of the temperature brings the liquid at last substance in an extremely fine state of division and mixed to a point at which cohesion ceases, the molecules fly apart with the air; as in the case of oxygen and hydrogen a union freely, and the third or gaseous state begins. Under the re- of the two takes place instantaneously throughout the mixture.

Explosives are not always combustible substances, and their explosion is not the result either directly or indirectly of their rapid combustion. A good example of this class of explosives is found in chloride of nitrogen. Neither of its constituents will unite directly with oxygen, but they are wedded tween collisions, being small compared with the dimensions to each other so slightly that each seems equally eager for divorce on the slightest provocation. It is the dissociation of this substance, which suddenly passes from the liquid obtains when the gas has been so rarefied that the collisions to the gaseous form, that renders it a dangerous explosive. Many other nitrogen compounds behave in a similar manner; path of the molecules being so long, on an average, that such, for example, as the iodide nitrogen, formed when iodine is washed with ammonia.

> Then follow the nitro compounds, or nitrous ethers, familiar among which are nitro-cellulose, nitro-glucose, nitrostarch, and nitro-glycerine. These substances, which are so readily formed by treating cotton, glucose, starch, or glycerine with strong nitric acid, contain an atom of nitrogen united with two of oxygen. This nitro group is a mischievous partner, and is pretty sure to break up any stock company that he gets into as a member. He is not satisfied to walk out peacefully, but like Goliath pulls the whole fabric down about his ears. Although nitro-glycerine requires a high temperature to explode it, a very slight shock or jar will set up decomposition. Nitro-cellulose, or guncotton, on the other hand, burns quietly but rapidly. The former produces a powerful effect when exploded without confinement, as on the surface of a body; gun-cotton can be exploded on the open hand without inconvenience.

Another nitro compound of some interest as an explosive If we try to follow in imagination the free molecule in its is picric acid, a trinitro-phenol, formed by treating carbolic 3788 flight into unlimited space, it loses all known properties of acid with strong nitric acid. The nitro groups here, as in nitro-benzol, seem to possess an entirely different position, the result not being, as in nitro-cellulose, a nitrous ether. The potassium and some other salts of this acid possess explosive properties.

Finally we have a class of bodies known as fulminates. They have the same percentage composition as the harmless ton, to visualize it as a little hard spherical body, or, with cyanates and cyanurates, with which they are said to be Boscovitch or Faraday, to regard it as a center of force, or polymeric. They consist of a metal combined with carbon, accept Sir William Thomson's vortex atom. But if the in- oxygen, and nitrogen in the proportion of their atomic

	Linaloes Wood. By J. MOELLER	3796	dividual molecule is not solid, a fortiori it cannot be re-	weights. Fulminating mercury was discovered by Howard
	Prediction of Chemical Elements Lecture Experiments	3796 3796	garded as a liquid or a gas, for these states are even more	in 1800. It is made by dissolving 1 part of mercury in 12
	Turkey Red Oil Soluble in Water	3796	due to intermolecular collisions than is the solid state. The	of nitric acid (sp. gr. 13), and when cold it is mixed with
11	Hgyell's Muirhead's, McCarty's, Ergstrom's, Gutensohn's,	3790	individual molecules, therefore, must be classed in a dis-	11 parts of 85 per cent alcohol, and the mixture heated on a
	On Some Luminous Effects of Induced Currents. 10 ft pres	N791 3791	tinct state or category "	water bath. It must be removed from the fire as soon as it
	An Improved Thermo-electric Apparatus. 4 figures	3792	Further on Professor Crockes takes up again the son	begins to show turbidity then left to gool desented and
1	Potsto.		rutulei oli riolessor crookes takes up again the con-	begins to show turbinity, then left to cool, decanted, and
	Hurbugs in Horticulture, By PETER HENDERSON	3796	sideration of the molecule, and describes it as the only true	recrystallized from boiling water. It crystallizes in white
	Sulphate of Iron and Cranberries	\$797	matter. "What we call matter is nothing more than the	silky needles. It detonates with great violence when for-
V	NATURAL HISTORY Digestion of Food by the Horse when at	0101	effect upon our senses of the movements of molecule. The	cibly struck, hence it is used in percussion caps, torpedoes,
	Activity of Bees. By E. ERLENMEYER and A. V. PLANTA-	3798	space covered by the motion of molecules {from which we	and the like. Ten grains of this substance produces 4
	Intermittence of Phosphorescence in Fire Flice	8798	derive our idea of continuous matter] has no more right to	cubic inches of permanent gases, but at the high tempera-
	On the Nature of the Phosphorescence of the Glow Worm Tuckaboe or Indian Bread 1 figure	8798	be called matter than the air traversed by a rifle bullet can	ture of explosion occupy far more space. The explosion is
V	I. PHYSICS Capillarity. ByGEO. H. STONE. Leature explaining	5198	be called lead From this point of view then matter is but	so sudden as to be particularly dangerous when in large
	capillarity experimentally and without resorting to the higher		a mode of motion, at the shaelute range of temperature the	magaza Mixed with 20 per cent water it can be triturated
	Production of Cold in Ice Machines. By TESSIE DIT MOTAY and	3792	a mode of motion; at the absolute zero of temperature the	masses. Mixed with 50 per cent water it can be inturated
	The Law of Distribution according to the	8798	intermolecular movement would stop, and, although some-	on a marble slab with a wooden pestle, but when dry must
	Atmospheric Substance which Absorbs the Uultra Violet Solar		thing retaining the properties of inertia and weight would	be kept in small separate portions. One kilogramme $(2 \cdot 2 \cdot 1 b)$
	The Fourth State of Matter. By Prof. CROOKES	3794 3784	remain, matter as we know it would cease to exist "	of mercury will make enough fulminate to fill 57,600 gun
5	II. ARCHITECTUREWorcester Cathedral. 1 full page engrav-		Thus, whether we pursue our quest of the ultimate basis	caps, but their preparation is not unattended with danger.
	Artists' Homes, No. S. Mr. Henry Holiday's house at Home	3788	of matter atomward or massward we lose matter as a	Fulminating silver is made by the action of nitric acid and
	stead, ng. Stikures. Perspective of "Oak Tree House."-First		in matter atom and of massward, we lose matter as a	alashal an aituate of allow
	noot hum	3790	reality the moment we eliminate molecular interaction; and	aconor on intrate of silver.