to the cost of fuel required to heat the ovens. By utilizing the escaping heat of the retort ovens, and utilizing the waste gases for firing the ovens, a double process of economy is obtained.

The by-products of peat coke are obtained in the form of commercial distillates. About one-third of the peat used for coking is converted into pure coke, one-third into gas liquor, and one-third into tar. From the gas liquor there are derived several other commercial products. One of these is the valuable methyl alcohol, which is assuming such important commercial value in our industries. Another is acetate of lime, and a third sulphate of ammonia. With these different articles selling at present market prices, one pound of peat is raised in value to nearly five times that paid for it in the open market.

The peat coke is a firm, jet-black substance that is as pure as charcoal. It has a thermal value of nearly 7,000 calories, varying a little according to the quality of the peat used. Its value for certain industries is considered much higher than coke made from any other process. It is particularly highly prized for smelting foundry iron, copper refining, and other metallurgical processes. For blast-furnaces it is also excellent, but it is too high-priced for general use in smelting iron ores. In Germany it sells as high as $9.50 to $11.50 per ton, and as its supply is still small the demand at these prices exceeds the supply.

The coke for burning purposes is a smokeless fuel, and it possesses all the merits of our best anthracite and charcoal. It can consequently be used in place of charcoal in all industries where a smokeless fuel is absolutely necessary for success. It is employed in place of anthracite only in a comparatively limited field, and it may never come in as a substitute for this fuel to any extent.

As a fuel for direct use in power plants, peat has less actual thermal value than coal or even the brown or lignite coal which is of comparatively recent geological formation. Peat is of such recent geological formation that it is only slightly carbonized. Its thermal value depends upon its composition. In some parts of the country the "mud peat" has a very low order of vegetable composition, and its value is relatively small for fuel purposes. These mud-peat bogs, however, furnish excellent fuel material when they are properly cut and dried for compression. The "mud peat," when dried by air until "bone-dry," has a calorific power of from 9,600 to 14,000 British thermal units per pound. This represents about 65 per cent of that of the best American coal. The wet peat of the mud bogs, or those furnishing the best material, weighs from 100 to 125 pounds per cubic foot. This weight, when dried in the open air or by hot-air blasts or in ovens, is reduced to 50 or 55 pounds. In this condition the fuel is hard and tough. It is not easy to cut it with a knife or saw, but it can be cracked or split with a heavy implement quite easily.

THE SORTING OF ATOMS.

BY PROF. A. W. BICKERTON.

The discovery of radium, and the compound nature of an atom, has so fascinated the popular mind, that scientific discoveries of equal importance with regard to the whole atom have been neglected. The great physicist whose early death was such a loss to science—Clerk Maxwell—told us that without energy, by intelligence alone, that if the atoms could be sorted into their different velocities, the whole conception of the fate of the cosmos would change. Such a power has been found to be in action, and the demons demanded by Clerk Maxwell are replaced by natural physical laws, and this discovery has shown that Clerk Maxwell is right, for the possibility of an immortal cosmos grows up with the knowledge of this power of the sorting of atoms, and Lord Kelvin's magnificent generalization of dissipation of energy, although still true as regards the solar system and the visible universe, fails when treating of the cosmic whole.

A jar of gas is a dust swarm of nature's ultimate particles. It is a giddy reel of moving molecules; sometimes the particles are detached atoms, as in the case of such gases as the newly discovered helium, argon, neon, etc. Sometimes the molecules are groups of atoms, as in the case of oxygen and carbonic acid. A particle of free oxygen consists of two similar atoms locked in a close embrace. If a piece of smouldering carbon be plunged into a jar of oxygen, there is such a great heat produced by the attraction of the molecules, that it bursts into a brilliant light. Heat is a violent motion of molecules. The heat produced causes the oxygen pairs to strike one another so violently that they part company, and both of the two isolated atoms are then clasped by a carbon atom, and built into a group still more firmly locked together than were the oxygen pair. Carbon has a great attraction for oxygen. We call the force that attracts them "chemical affinity." So tremendous is the pull, that, as the atoms rush together, the blow they strike causes the particles to shiver so violently that the whole mass becomes white-hot. Heat may be a vibration or shivering of the ultimate atoms, or it may be the free flight of the particles we have called molecules. The hotter a gas, the more rapid the dance of its countless particles; so the new molecular groups of carbon and oxygen that we call carbonic acid move with tremendous velocity, striking each other and the sides of the jar. Had we sealed the jar when we plunged the glowing carbon into oxygen, so great would have been the force with which the particles would have struck the sides of the jar, it would probably have been blown to pieces. The pressure that produces explosions is caused by a bombardment of the ultimate particles of matter.

Some gas particles are light and some scores of times as heavy, but light or heavy, the same number of particles are required to fill the same jar. So the density of a gas depends on the weight of its molecules. Carbonic acid is so much heavier than the air that the gas can be poured from one jar to another; while so light is hydrogen that an open vessel has to be held upside down to hold it. If we half fill a jar with oxygen, and then fill the remainder with hydrogen, the hydrogen will float above the oxygen. Yet, such is the dance of the molecules that the hydrogen particles will travel downward, and the oxygen upward, until there is a uniform mixture throughout the jar. If, however, the jar be a tall one, it will be found that the hydrogen will reach the bottom four times as quickly as the oxygen reaches the top, for the hydrogen particles move four times as quickly as the particles of oxygen. When a gas particle is four times as light, it moves twice as fast. When it is sixteen times as light, it moves four times as fast, and so on. As the physicist puts it, the speed of a particle of gas varies inversely as the square root of its molecular weight.

The hydrogen particle is sixteen times as light as the oxygen particle, so it moves four times as fast.

The atoms are exceedingly minute. A pea is made up of many millions; so when free they can get through very small holes. They wander easily through the pores of a plaster partition, also through most membranes. Hence, if an India-rubber balloon be filled with hydrogen, the atoms soon find their way out. Fill a collodion balloon with this gas, and it floats; presently it becomes smaller and then sinks. The hydrogen has wandered away, and a smaller number of air particles have wandered in to take its place.

All through the atmosphere, in addition to being carried by winds, the atoms thus wander, so that, if we allow time enough, the composition of a confined mixture of gases gets to be uniform throughout, and this, whether the gas be held in its place by gravitation, as it is in the atmosphere, or be laid carefully layer above layer in a closed jar.

But nature can also sort as well as mix atoms. Chemical affinity enables us to sort a mixture by putting something in that will take one and leave the other constituents of a mixture. Thus air is a mixture of oxygen and nitrogen. If we burn phosphorus in it the oxygen is taken away, and the nitrogen left.

But nature has another mode of sorting molecules, by making them outrun one another, when all are traveling in one direction. In such a race, if hydrogen had a velocity of sixteen, oxygen would only have a speed of four, while uranium would be traveling at the rate of one only. But how can the atoms be started on such a race? By grazing impact of stars or dead suns. In the Philosophical Magazine for August, 1900, it is shown that such a grazing impact will result in the parts that meet one another being cut from the remainder of the stars, coalescing, and forming a new body, and this body may have so small a mass and be at so high a temperature that the velocity of its molecules will be great enough to escape the body entirely.

When all are fairly started on their outward journey, the light atoms will be in advance, and the other cosmic elements in concentric shells, in the order of their atomic weight. It will be as though shot, bullets, and cannon balls had each similar energy, the shot having an enormous velocity to make up for the mass of the cannon balls; and this is the law of the distribution of energy among molecules. Molecules at the same temperature have the same energy. It will easily be seen that not merely can the light molecules escape from the body produced by the collision, but they may have a velocity sufficient, and in fact often would have velocity sufficient to escape the very universe itself; and having escaped it, might travel across the intervening space to other cosmic systems, but when at the point most distant from either, they would travel more slowly than in any other position. The velocities observed in Nova Persei were many thousands of miles a second. And it is easily seen that in the case of indiscriminately moving particles, where they move slowest there they will tend to be more thickly spread than elsewhere. Hence here is a new aggregating agency the reverse of gravitation, that causes a concentration depending on the lightness and power of flight of atoms, whereas gravitation tends to collect the heavier particles. So that in old universes, the heavier molecules will predominate, but incipient universes will be built up of the light atoms. In the course of time other agencies come into work that modify this segregating action. These agencies are very fully discussed in a book on the subject entitled "The Romance of the Heavens."

The formation of these aggregations of light molecules carries us to a stage beyond the theory of dissipation of energy, and a study of the whole subject shows that the cosmos as a whole is a cyclical process in which we have rejuvenescence of universes, just as it has long been seen that collision would give us rejuvenescence of dead suns; and the cosmos as a whole is thus seen to be infinite and immortal.

Thus this fact of nature's power of sorting molecules which goes under the name of "selective molecular escape," entirely alters our conception of the whence and where of the universe.

AUTOMOBILE NOTES.

The fact that out of seventy-six cars that participated in the St. Louis tour at one place or another, but one American car failed to reach its destination on account of a serious break down, should be distinctly encouraging to our manufacturers. The only other machines of American make to drop out were a huge Peerless racer, which ran into a railway train, and an Oldsmobile touring car, which was burned in a garage. A large Mercedes touring car which met with many breakdowns, finally broke its crankshaft thirty miles before reaching St. Louis, while another car of the same make went through without mishap. This would tend to show that it is a difference in men and individual machines, rather than the inferiority or superiority of any one type, that accounts for failure or success. The lightweight cars had a decided advantage in many ways, besides less tire trouble. A car equipped with solid tires broke a steering-knuckle. The last day's run was through very muddy roads, and it is worthy of note that most of the cars got through.

The creating of a non-stop (i. e., without stopping the motor) record of 3,400 miles in connection with the St. Louis tour by running from New York to that city and back again—a feat which was accomplished by Mr. F. A. La Roche in a Darracq touring car—was doubtless the hardest test of this character a machine has ever been given. When it is understood that the car was run night and day for thirteen days over the worst of American roads without its motor having a second's rest, one marvels at the degree of perfection the automobile motor has already attained. Altogether, the motor ran fifteen days and two hours unceasingly, which is a much longer time than has been the case in any non-stop test heretofore.

Apropos of touring, an attempt is being made by L. L. Whitman (who last year crossed the continent in an Oldsmobile) to repeat the journey with an air-cooled car. The four-cylinder Franklin is the machine he is using. He reached Denver in sixteen and one-half days, or in thirteen and one-half days better time than the previous record, so in all probability the time of sixty-one and a quarter days for the complete journey, made last year by Tom Fetch with a Packard car, will be beaten.

Many motor car accidents have been attributed to the collapse or bursting of pneumatic tires while traveling at high speed, causing the car to swerve violently and come into collision with an object. Practical motorists, however, have considered this a fallacious contention, and for the purpose of illustrating the error of the deduction, Mr. S. F. Edge carried out a series of interesting experiments recently at the Crystal Palace, London. For the purposes of the demonstration, a section of the track was covered with broken glass and boards were laid down with the sharp edges of chisels projecting, while in addition a specially prepared sheet of iron was employed which was thickly set with iron spikes. Mr. Edge used the 100-horse-power car which had contested in the Gordon Bennet race, and drove it over the prepared patch at 50 miles an hour. One front tire was punctured, but the car did not swerve. On repeating the process one of the back tires was deflated, but still the car kept perfectly straight. The front tire on the near side was then deflated, while the cover on the near side rear tire was removed over the entire circumference of one edge, so that it was holding on by one edge only instead of two, and in a deflated condition instead of inflated. He then started off with the intention of wrenching off the back tire if possible. The car was driven in a perfectly straight line, notwithstanding the two flat tires for some distance, and then the demonstrator swerved it from side to side when driving it at about 45 miles an hour. The cover flew off, but even then, on the bare rim, the car could be steered in a perfectly straight line. The result of these experiments showed that it is not the collapse of tires to which accidents are due, but to improper driving and insecure holding of the steering wheel, unprepared for any emergency, on the part of the driver.