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THE SCIENTIFIC AMERICAN SUPPLEMENT
No. 179,
For the Week ending June 7, 1879.

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THE TRAJECTORY OF MOLECULES.

In "The Fourth State of Matter," SCIENTIFIC AMERICAN, January 25, last, an account was given of the experiments made by Mr. William Crookes, showing the high probability of a fourth state of matter, more ethereal than the gaseous, in which matter take on an entirely new set of properties. At a social meeting of the British Royal Society, April 30, Mr. Crookes exhibited a series of experiments illustrating still further the curious behavior of electrified molecules in extremely rare media.

By the improvements made in the Sprengel pump by Mr. C. H. Gimingham it is now possible to produce vacua in which the pressure is measured in millionths of an atmosphere. It is with vacua so produced, in the more perfect of which the pressure is as low as one millionth of an atmosphere, that Mr. Crookes' investigations were conducted.

It will be remembered that the discoveries in question were made in the dark space around the negative pole within a vacuum tube and separating it from the luminous glow. This dark space was found to be a region of molecular activity similar to that in front of the vanes of a radiometer, by which activity the negative pole, when free to move, is set in motion.

The phenomena exhibited in his first published experiments—the phosphorescent effects produced by molecular impact, the illumination of lines of pressure, the casting of molecular shadows, the magnetic deflection of molecular streams, and the like—were shown anew, and supplemented by even more beautiful effects, though nothing absolutely new was developed.

In some of the experiments variously-shaped poles were used, causing the molecular streams to converge to a focus, to diverge, or to move in parallel lines. By one apparatus the four principal phenomena of molecular physics in high vacua—namely, the phosphorescent light of molecular impact, the projection of molecular shadows, the magnetic deflection of the trajectory of molecules, and the mechanical action of molecules projected from the negative pole—were beautifully illustrated.

The vacuum tube inclosed a circular concave negative electrode, and at its center of curvature a light wheel was pivoted upon a horizontal axis. The wheel was a disk of thin mica, carrying around its periphery a number of equidistant radial vanes of aluminum, making the wheel look like a waterwheel. When the tube was placed in connection with an induction coil, the stream of molecules concentrated upon the wheel fell in line with its axis, in which case no motion resulted. But on bending the stream of molecules up or down by magnetic action the focus of impact would fall above or below the axis, and the wheel would be set to spinning at a lively rate.

Very brilliant effects were also produced by causing the molecular stream to fall on naturally phosphorescent substances, as, for example, diamonds. At such times different sorts of diamonds were distinguished by different colors—blue, pale blue, orange, red, green, and pale green—African diamonds emitting a blue phosphorescence. Rubies, on the other hand, whatever their normal tint, all assumed under the molecular hail the deep "pigeon's blood" red, characteristic of a fine ruby. Even white precipitated alumina gave under the molecular stream the same ruby color, though normally without a trace of color.

Thus far these researches of Mr. Crookes seem to be brilliant rather than instructive in their results; but it is altogether too early to pronounce upon their possible value.

THE INTERNATIONAL CANAL CONGRESS.

An international canal congress, for discussing projects for the construction of an interoceanic ship canal across the American isthmus, met in Paris May 15. M. Ferdinand de Lesseps was fitly chosen president. Since the main object of the convention was to compare routes and decide upon the one to be recommended as a practical enterprise, the principal interest naturally centered in the Committee on Technique.

Up to this writing, May 22, six routes have been under examination and discussion, namely, the Nicaragua route, the Panama route, the San Blas route, the Tiati-tolo route, the Tuyra-Caquirri-Atrato route, and the Atrato-Napipi route. At first the Tiati-tolo route, known as Lieutenant Wyse's lockless canal and tunnel route, seemed to have the brightest prospects, from the strong party and personal influence known to be working in its favor. The Sub-Committee on Tunnels, however, found that its probable cost had been greatly underrated, and that under the most favorable conditions it would cost $160,000,000. This discouraging blow was followed by such an able presentation of the impracticability of the scheme by the English engineer, Sir John Hawkshaw, that the project was abandoned.

Already the choice seems to be narrowed to two projects, the Nicaragua route and the Panama route, and a decision will probably be reached in the course of a week.

A Medal for Peter Cooper.

At the late meeting of the British Iron and Steel Institute in London, the Bessemer Medal of the institute was presented to the venerable Peter Cooper as "the father of the iron trade in America." In his presentation speech the President spoke of Mr. Cooper's half-century connection with the iron trade, his Baltimore rolling mill in 1830, his building and running the first American locomotive, his extensive iron works at Trenton, and especially the founding and direction of the great Cooper Institute in this city. In view of the fact that it is through the efforts of Mr. Cooper and other leaders in the American iron trade that England's greatest rival in iron production has almost reached supremacy, this recognition of his labors by the English iron and steel producers is particularly handsome.

SCIENCE AS A DETECTIVE.

A correspondent tells at greater length than we have space for the story of an attempted fraud which was exposed by chemistry.

An emery wheel guaranteed to stand 600 revolutions was run at the speed, of 1000 revolutions, and burst, doing a large amount of damage. A suit to recover was instituted, based on a letter written by the seller of the wheel, in which the strength of the wheel was rated at 1,600 revolutions. While in the office of the prosecutor endeavoring to effect a settlement, the defendant observed that a certain make of ink was used, and he learned by a casual inquiry that the same ink was used exclusively by the prosecutor. The defendant had for several years used another ink. Taking samples of the two inks to a chemist, he was able after analysis to secure a solvent for the one which would not affect the other.

The case came to trial. Evidence was taken as to the kind of ink each party employed. Then the chemist was called, and in the presence of the jury applied the solvent, which removed the interpolated "1," and left the rest of the writing untouched. The proof of the forgery was sufficient, and the case was dismissed, leaving the dishonest prosecutor to defend himself from a criminal charge.

A NEW REFRIGERATING LIQUID FROM BEETS.

In Europe the principal supply of sugar is derived from beets; the annual production of beet sugar being now seven hundred thousand tons. Besides this a large quantity of beet molasses is produced, a portion of which is distilled and a coarse sort of whisky made; the stuff remaining in the retort yields potassium salts, which are employed as fertilizers. Sugar, spirits, and potash have heretofore been the chief products manufactured from beets. But Mr. Vincent has now succeeded in realizing from the refuse that remains after the beet molasses distillation, a combustible gaseous body, which is easily condensed into liquid form, and is called chloride of methyl.

This liquid, obtained as stated from beets, is used in the preparation of some of the aniline colors; but it is now found to be especially valuable as a refrigerating agent By its rapid evaporation a temperature of—55° C., or 67° F. below zero, may be maintained, which is far below the freezing point of mercury. Prof. Huxley says that by this means mercury (which freezes at 39° F. below zero) may be frozen by the pound. For the manufacture of ice this new beet root product promises to become of much importance.

MAGNETIC MOTORS.

Is there an available source of energy in magnetism? There are very many inventors who believe that there is, and every year many attempts are made to produce economical magnetic motors. A short comparison between the force of magnetism and other natural forces will answer our question.

An iron steamship plies between New York and Liverpool; it is more or less a magnet under the influence of the earth. Yet the helmsman does not allow for the attraction of the north or south poles of the earth upon this magnetic matter. This attraction is immensely inferior, even if the steamship were made of steel and been magnetized to saturation, to the drift of the tides, or even to the effect of the gentlest breeze. The force of gravitation, however, sinks the heavy vessel deep in the water, and is ready to draw it with all on board to the very bottom of the ocean. While the force of magnetism decreases or remains constant when the masses of the attracting magnetic bodies are increased, the attracting force of gravity steadily increases with the masses of the two bodies, between which this attraction acts.

It is sometimes proposed to utilize the magnetism of the earth in magnetic motors by supplying any waste in the energy of a permanent magnet from the store in the earth. Let us see how much this force of the earth's magnetism is in comparison with the force of gravity, which is our universal measuring force, so to speak. Suspend in a vertical position from one end a cylindrical bar of iron which is about one foot in length. It should be hung by a very short wire or thread from its north pole. Hang beside it a brass rod of the same dimensions, and provide it with the same length of suspension. Then set the two rods to swinging, and count the number of swings which each makes in a given number of seconds. It will be found that the two rods will accomplish very nearly the same number of swings in the same time. The rods will differ very little in weight, and their moments of inertia will be very nearly alike. The vertical force of the earth's magnetism, therefore, must be small in comparison with the force of gravitation; for the iron bar is acted upon by both gravity and the earth's magnetism, and yet it vibrates at nearly the same rate as the brass bar. An iron bar, such as we have used in the above experiments, will be rendered feebly magnetic by the earth's magnetism, and could hold a light cambric needle at its extremity; but nothing more. This is the force from the earth which we can count upon to renew the magnetism of steel when it has been deprived of it.

It has been said that it is possible to lower the energy of a magnet by vibrating an armature composed of a thin plate of iron in front of the magnet. An experiment will speedily