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Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

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FORCE AND ENERGY.

In the usual treatment of the science of mechanics and physics, three central ideas are generally made very prominent. These are force, work, and energy. The order in which they are given is an index of the treatment of the subject. Force is defined; then work is described as the exercise of force along a path through space; and, finally, energy is defined as the capacity for doing work. Nothing is more certain than the fact that a complete and working understanding of the relations of force and energy is essential to the study of mechanics and physics, and the great errors of the world of scientists and investigators have been due to ignorance or misconception of these relations. It is but a few years since the mistaken doctrine of the conservation of force was definitely abandoned for the true doctrine of the conservation of energy. Such abandonment indicated a very recent understanding of the true relations of force and energy, for the erroneous expression conservation of force is hardly yet extinct. The many attempts at the production of perpetual motion indicate a want of appreciation of the fundamental bases of science. The search is still in progress, hopeful enthusiasts refusing to accept the truth that energy is as indestructible as matter, and as impossible of creation.

But it would seem that in the threefold division force, work and energy, there is either one word too few or one word too many. Energy can be expended, and if expended, produces an exact equivalent of other energy. As fast as one quantity of energy is expended or disappears, another quantity exactly equal, though it may be of widely different form, is produced. The sum of all the energies of the universe is always equal. Now, what distinct existence can work be said to have? When energy is expended it does work; it reproduces an equal amount of energy; therefore the term work must be accepted as the synonym for the "production of energy." It would seem better to abandon the term "work," as ordinarily used, to establish the basis of mechanics, unless a synonym for the "expenditure of energy" could be found. The term "working" might supply this synonym. But the real basic terms in mechanics should be either the two, force and energy, or the four, force, energy, expenditure of energy and production of energy.

The terms work and working may be substituted for the last compound terms. As it stands now, there is a strong tendency to place energy in its definition as a sort of subsidiary to work. It should be treated as the all-important thing, and work as a convenient expression of a single one of its phases. An advanced treatment of the subject of mechanics might be based on the entire omission of the term work, making it a science of force and energy, treating work as the expression of the concrete only.

The realization of the true meaning of work makes the understanding of the impossibility of perpetual motion much clearer. No machine can produce energy or do work without an exact equivalent of energy being put into it. There is a further aspect of the subject. After all the coal is burned, after the sun has cooled down and after all the possibilities of establishing differences of temperature will have disappeared, the energy of the universe will be the same as ever, but no work will be possible, no energy can be produced. This supplement to the doctrine of the conservation of energy tells us that the available energy of the universe is tending to zero.

But as the first doctrine proscribes perpetual motion, the second opens up a possibility of a false or pseudo-perpetual motion in the conversion of unavailable into available energy. This is in the suggestion of Clerk-Maxwell, who fancifully imagines a "demon" at some future time separating the particles of matter into two divisions moving in opposite directions, without expending any energy, but simply rendering available the existing energy of all things.

If man could but separate the molecules of a gas into two sets, one as they beat to the right, the other as they beat to the left, he would be doing the act of Maxwell's demon, and the energy of the air would be made available. It would be utilized in the remixing of the molecules, and the work done would be measured by the energy abstracted from the air. The molecular motion would be lessened, or, what is the same thing, the temperature would be lowered. But the same sum of energy would exist, could we but render it available.

It is as if man started in the world with a quantity of matter or weights placed at a height and an equal quantity of weights at an equal depression below his level. Since the beginning of the human race man would be industriously raising one set of weights by lowering the other. Thus all would tend to reach the same level, and when this would be reached neither set would have any advantage of position over the other, and available energy would have reached its zero. But the same total of energy would be present, and if not zero would involve the idea that the middle plane is above the zero point. This is the same as saying that if the universe lost all its available energy it would not reach the absolute zero, where all molecular motion stops. But if the degradation of energy shall ultimately bring all matter to the absolute zero, then Maxwell's demon would find his occupation gone, and like Macaulay's New Zealander could only sit still and contemplate the ruins of the past.

THE HEAVENS IN MAY.

The interesting assemblage of planets in the evening sky will be increased in number during May by the addition of Mercury, which is in superior conjunction with the sun on the evening of the 4th. But not until the end of the month will the little planet be far enough east of the sun to be well seen. At that time it will be near Jupiter in the constellation Gemini. Early in June it will be in rather close conjunction with Jupiter.

Venus moves during May from Taurus into Gemini, passing a little more than two degrees north of Jupiter an hour before noon on the 18th. As Venus has now become so bright as to be visible to a keen eye at midday, it will be possible, on this occasion, to find Jupiter in the daytime with the aid of Venus, and to see them both with the aid of a strong field glass. The experiment should be made between two and three o'clock in the afternoon, when the two planets will be near the meridian. At the end of the month Venus will be near the twin stars of Gemini, Castor and Pollux. She will then have attained about one-half of her maximum brightness.

Mars, which passed Jupiter on April 25, will continue to move eastward during May, and at the end of the month will be in the eastern part of Gemini, near Venus, with which planet it will be in close conjunction on the 5th of June.

Jupiter, following the example of Mars, whom he replaced in the public eye during the latter part of the winter, is becoming less conspicuous as he draws nearer the sun, and early in June he will cease to adorn the sunset sky. Jupiter remains in Gemini, moving slowly eastward, and at the close of May will be near the third magnitude star Epsilon.

Saturn replaces Jupiter, advancing with the annual revolution of the heavens from the east. This splendid and unique planet crosses the meridian at the opening of May about 11:30 P. M., and at the end of the month about 9:30 P. M. It is in the eastern part of the constellation Virgo, near the fourth magnitude star Kappa. The only star in its neighborhood comparable in brightness with Saturn is Spica, the leading brilliant of Virgo, which shines about 12° almost directly west of the planet. Saturn's rings now present a beautiful appearance with a 3 inch or 4 inch telescope. It is the north pole of the planet that now leans earthward, and consequently it is the north side of the rings that we see. The earth is between 16° and 17° above the plane of the rings. Their major axis appears about 42" in length and their minor axis about 12". A good 4 inch telescope is capable of showing five of Saturn's satellites, Japetus, Titan, Rhea, Dione, and Tethys. The other three, Hyperion, Enceladus and Mimas, are visible only with more powerful instruments. No one who has an opportunity to look through a telescope should fail to see Saturn. Its rings are an unceasing source of wonder, and no picture ever made of them is a perfect likeness.

Uranus is in Libra close to the fifth magnitude star Nu and about 4° east of Alpha, a star of the third magnitude. It may assist the reader in finding the place of Uranus to know that it is about 14° east-southeast of Saturn. As a telescopic object for amateurs it is hardly worth attention. Uranus is in opposition to the sun on the 8th.

Neptune is very near the fifth magnitude star Iota in Taurus, between the horns of the imaginary bull, and there, on the 19th, it will be in conjunction with Mercury. The conjunction will not be close, however, Mercury being 3½° to the north.

May opens with the moon at first quarter in Cancer. The moon fulls on the evening of the 8th in Libra and attains last quarter on the afternoon of the 16th, in Aquarius. The new moon phase for May occurs in Taurus on the 24th, at 7:46 A. M., and the second occurrence of first quarter for the month happens on the morning of the 31st in Leo.

The moon pays her May visits to the planets on the following dates: To Saturn on the 7th at 8:35 P. M.; to Uranus on the 8th at 9:04 P. M.; to Neptune on the 25th at 5:53 A. M.; to Mercury on the 25th at 10:44 P. M.; to Jupiter on the 26th at 7:42 P. M.; to Venus on the 27th at 10 A. M.; to Mars on the 27th at 6 P. M.

Among objects of special interest to possessors of small telescopes that may be noted this month are a number of beautiful double stars. One of the finest of these is Gamma Virginis, a wonderful binary star whose components were so close together in 1836 that no telescope then in existence was able to separate them. Now, however, a 3 inch splits them easily, their distance being nearly 6". They are both of the third magnitude and their equality in this respect adds to the beauty of the sight. To me there is always an impression of rivalry in a double star whose components are nearly equal. Each seems to be shining its best, as if conscious of the presence of the other. A still more beautiful double, though more difficult, and requiring a better telescope to be well seen, is Epsilon Bootis. The peculiar charm of this star depends upon the splendid contrast of colors presented by its two unequal components. The larger star of the two is of the third magnitude and deep yellow; the smaller star is of the sixth magnitude and bright green. Their distance apart is less than 3", and on account of the inequality of their magnitudes a 4 inch glass is likely to give a more satisfactory view of them than a 3 inch, although the latter is capable of separating them and of showing their colors also.

Another double star much resembling Epsilon Bootis, but easier to separate, is Gamma Leonis. The larger component is of the third magnitude, and the smaller of the fourth, the first being yellow and the second green or greenish blue. The distance is about 3¾".

Look also with a 3½ or 4 inch glass at Iota Leonis, whose larger star is of the fourth magnitude, color pale yellow, and the smaller star of the seventh magnitude, color light blue; distance 2½".

A very beautiful and easy double, now well placed for observation, is 12 Comæ Berenicis. Even a 2 inch telescope will show this readily, as the distance of the components exceeds one minute of arc. Their magnitudes are fifth and eighth, and their colors yellow and rose red or lilac.

Everybody of course knows the splendid Mizar in the middle of the handle of the Great Dipper. An average eye sees its companion Alcor without optical assistance. With a 2 inch or 3 inch telescope Mizar is seen to be itself double, the larger star being of the third magnitude and white, and the smaller of the fifth magnitude and light emerald.

The beautiful Cor Caroli, the brightest star in the constellation Canes Venatici, must also be mentioned. The telescope shows that it consists of two stars, about 20" apart, the larger of which, of the third magnitude, is white, while the smaller, of the sixth magnitude, or under, is distinctly lilac.

Those who are not familiar with the constellations will need to use a star atlas for finding the double stars just described. Their places cannot be satisfactorily indicated by mere description.

GARRETT P. SERVISS.

THE NATIONAL ACADEMY OF SCIENCES.

The meeting of the National Academy of Sciences that was held in Washington recently was of more than usual interest, owing to the special character of the business transacted.

The Academy, as many of the readers of the SCIENTIFIC AMERICAN know, but of which fact the general public persists in remaining very ignorant, is the highest scientific body in the United States, and an election to its membership is the greatest honor that an American can expect to receive at the hands of his countrymen. To this Academy all questions of scientific importance that come up in the administration of the government are referred for final decision. Even matters of the utmost delicacy, such as one involving the life or death of a geological survey, have been passed upon by them and their decision accepted without an appeal. Its membership is limited by law to 100 members, and it is never full. Indeed, in recent years, owing to the large number of candidates proposed, no choice was possible, and the number of members had been reduced by death to below ninety.

Two meetings are held each year. One on the third Tuesday in April, always in Washington, D. C., and the other, usually elsewhere, about the 1st of November. The stated meeting, as the one held in the spring is called, was convened on April 16 in the audience room of the United States National Museum, and continued its sessions until April 19.

Among the features of this year's meeting that gave it unusual prominence was the election of a new president. In the more than thirty years of its existence, for it was founded in 1863, by an act of Congress, the Academy has had but few presiding officers. Alexander D. Bache, who for so long a time filled the high office of superintendent of the United States Coast Survey, was the first to receive the presidency from the hands of his associates. From the inception of the Academy until his death, in 1868, he filled that place. His able colleague in Washington, Joseph Henry, the first secretary of the Smithsonian Institution, came next, and for ten years, with courtly grace, he presided over the meetings of the Academy. He died in 1878, and William B. Rogers, the founder and president of the Massachusetts Institute of Technology, was chosen as his successor. His term of office was comparatively short, and scarcely had four years elapsed when he was called to join the silent majority. The Academy then inaugurated a different policy, and Professor O. C. Marsh, of New Haven, so well known for his studies in paleontology, being at that time vice-president of the Academy, was confirmed in the higher office by his associates at the ensuing election. Professor Marsh was then and is still in the prime of his mature manhood. He filled the office with ability and judgment for two terms of six years each, and, having declined a third term, stepped down into the ranks again.

To fill his place the Academy has chosen a veteran, and Wolcott Gibbs, of Newport, R. I., the Nestor of American chemists, was given the high office of president of the National Academy of Sciences. To even briefly review the career of this eminent scientist would be an arduous undertaking and one that, to be well done, must be lovingly done; for among the teachers of science no one has so thoroughly succeeded in attracting students by the charm of his personal magnetism since the time of Louis Agassiz as Dr. Gibbs. A word or two must be given of his record.

Seventy-three years ago in February he was born in New York City, and after graduation at Columbia and study in Europe, he became a teacher of chemistry. In 1849, a date when several of the members of the Academy were not yet born, he was called to the chair of chemistry and physics in the College of the City of New York, and, in 1863, he went to Cambridge to accept the Rumford professorship in the Lawrence Scientific School of Harvard University. Having served there for more than a quarter of a century, he was made emeritus, and then retired to his home in Newport, where he devotes the leisure of his maturing years to the prosecution of original investigations. During the civil war he was a member of the executive council of the United States Sanitary Commission, and to him credit is given for the idea out of which the Union League Club has grown, of which he is the senior honorary member. In returning to its earlier traditions and choosing to its highest office the most distinguished of its members, the Academy has adopted a course that cannot but be of benefit to it.

A home secretary was also chosen at the recent meeting. Asaph Hall, who found the moons of Mars for the World in 1877, and achieved fame at the same time, was continued in the place that he had so acceptably filled for many years. The headquarters of the Academy are in Washington, and therefore it is desirable that the office of the secretary should be there also. Professor Hall was for many years connected with the United States Naval Observatory, and is now on the retired list, with leisure at his command.

In addition to the officers mentioned, George J. Brush, of the Sheffield Scientific School; Benjamin A. Gould, of Cambridge, Mass.; Simon Newcomb, of the United States Nautical Almanac; Ira Remsen, of Johns Hopkins University; George L. Goodale, of the botanical department of Harvard University; and Othniel C. Marsh, of the Peabody Museum of New Haven, were elected new members of the council.

Interest was not only confined to the election of new officers, for it extended to the new members who were chosen. Notwithstanding the number of vacancies, never more than five new members are chosen to the Academy at one time, and members can only be elected at the stated meeting. No candidates have been chosen since 1892, but this year four were agreed upon. They were: William L. Elkin, of the astronomical department of Yale University; Charles S. Sargent, who fills the chair of arboriculture in Harvard University, Cambridge; William H. Welch, of the Johns Hopkins University, whose recent researches in biology have been so valuable, especially in the direction of determining with exactness the presence of rabies in persons bitten by animals afflicted with hydrophobia; and Charles O. Whitman, whose researches in marine life have resulted in his recent appointment to the University of Chicago.

Besides the home members, three foreign associates were chosen. They were: Prof. Rudolph Lenckart, who for so many years has been in charge of the Zoological Institute in Leipsic, Germany; Prof. Sophus Jie, the famous Norwegian astronomer, who now fills the chair of that science in Leipsic; and Prof. Julius von Sachs, the director of the Botanical Gardens in Wurzburg, Bavaria. It is perhaps well to add that foreign membership is likewise restricted, and there are never more than fifty foreign members.

The Academy has also a substantial way of honoring scientists, for it is the custodian of several trust funds, from the interest of which gold medals are awarded from time to time for discoveries or advances made in special branches of science. Conspicuous among these is the Watson medal, derived from a fund of $13,000 left some years ago to the Academy by James C. Watson, from the interest of which "a medal is to be prepared to be awarded to the person in any country who shall make any astronomical discovery or produce any astronomical work worthy of special reward and contributing to the progress of astronomy." Four times has this medal been given; first to Benjamin A. Gould in 1887; then to Edward Schoenfeld, of the University of Bonn; then to Arthur Auwers, of Berlin, and last year it was awarded to Seth C. Chandler, of Cambridge, Mass., for his researches on the variations of latitude and the variable stars. The public presentation of the medal took place in Washington this year. The medal is accompanied by a gold purse of $100.

A medal resulting from a fund left to the Academy by Frederick A. P. Barnard, who for so many years was president of Columbia College, valued at $200 and known as the "Barnard Medal for Meritorious Service to Science," a copy of which is to be presented at the end of "every five years to the person who, during that period, shall have made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as shall be deemed the most worthy of such honor," is also at the disposal of the Academy. The first award of this medal was made this year, and the fortunate recipient was Lord Rayleigh, to whom it was given for his discovery of argon in the atmosphere.

Comparatively few papers were read at the recent meeting. In fact, the original programme contained only twelve titles; but others were announced subsequent to the arrival of out-of-town members. The scientific session, which is held in the autumn, is more likely to afford a larger number of contributions from the members. It will be held on October 20, in Philadelphia. One feature of the Academy that deserves a word, in conclusion, is that of the reading of biographical memoirs of each deceased member. This year one on Dr. Lewis A. Rutherfurd was read by Benjamin A. Gould.

George M. Phelps.

Seldom has death occurred with more sudden stroke than in the case of Mr. George M. Phelps, president of the Electrical Engineer. He was at the office of the journal on April 6, busily occupied with his duties, but suffering from a cold which kept him at home the following Monday. His associates attached no importance to it, but pneumonia set in swiftly and they, with a host of other friends, were dumfounded to learn that he had succumbed to the disease on Thursday afternoon.

Mr. Phelps was born at Troy, N. Y., in 1843, and received there a public and high school education, which he supplemented by continuous study through life. In 1861 he became connected with electrical interests in the shops of the American Telegraph Company, of which his father was superintendent up to its absorption by the Western Union Company in 1866. It will be remembered that the senior Phelps was one of the distinguished and successful inventors in the first telegraph group—a worthy companion of Morse, Vail, Bain, Hughes and House, and one whose work still stands in the Phelps ticker, Phelps telephone, Phelps printer and other apparatus. The son closely resembled the father in a love of beautiful mechanism and in a fine sense of accuracy and finish in the construction of electrical devices. From 1871 to 1879 the two were associated in the conduct of the Western Union factory in New York, and when the latter shop was given up, Mr. G. M. Phelps, Jr., was appointed superintendent of the New York factory of the Western Electric Company, a position he held until December, 1885. Early in 1886 he joined Mr. Franklin L. Pope, an old friend, in the conduct of the Electrician and Electrical Engineer, then published monthly. He took so kindly to electrical journalism that he acquired a proprietary interest in the property. When in 1890 the Electrical Engineer was expanded into a weekly and its business was incorporated, he was unanimously elected its president. He filled that capacity down to the day of his death, taking the most active part in the business management of the paper. Besides this, he was a frequent contributor to its editorial pages, rendering invaluable literary and technical service. Of many questions he was an easy master, and his judgment was at all times sound and keen.

Electrical Appliances in the Japanese War.

The war between China and Japan has shown that the Japanese readily turn to account any advantage offered by scientific appliances. Their seizure of the telegraph lines in Corea strengthened their position at once, and any breaks were quickly repaired by men who had been trained in actual construction as well as the manipulation of the instruments. The Japanese are facile copyists, and have brought the telegraphs of their insular kingdom to such a state of perfection since their introduction in 1870, that there is hardly a point on the vast coast line which could not be put into communication with the capital in a short time should a hostile fleet be sighted.

In field telegraphy the Japanese have made great advances. Their instruments are modeled upon the latest European forms. The poles are made in sections, the bottom one being provided with a brass foot to be forced in the ground, and the wire runs out from reels carried on light hand barrows. The telephonic system of police and fire alarms in Japan is very complete. The greater number of the Japanese vessels are lighted by electricity, and the skillful manipulation of their search lights in the war has excited favorable comment. Owing to the war, many of the lights and beacons have been extinguished on both the coasts of Japan and China, and false lights substituted, so that navigation has become perilous. The "submarine sentry" has rendered efficient aid in preventing disasters. This recently invented electrical instrument gives warning to a vessel going ten knots per hour when the depth of water falls below twenty fathoms, so that the usual soundings may be taken.