# Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

**TERMS FOR THE SCIENTIFIC AMERICAN.**

One copy, one year, postage included........................ $3 20
One copy, six months, postage included........................ 1 60

**Clubs.**—One extra copy of THE SCIENTIFIC AMERICAN will be supplied gratis for every club of five subscr bers at $3.20 each; additional copies at same proportionate rate. Postage prepaid.

**The Scientific American Supplement**

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly; every number contains 16 octavo pages, with handsome cover, uniform in size w th SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies 10 cents. Sold by all news dealers throughout the country.

**Combined Rates.** —The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, postage free, on receipt of *seven dollars*. Both papers to one address or different addresses, as desired.

The safest way to remit is by draft, postal order, or registered letter.

Address MUNN & CO., 37 Park Row, N. Y.

☞ Subscriptions received and single copies of either paper sold by all the news agents.

**Publishers' Notice to Mail Subscribers.**

Mail subscribers will observe on the printed address of each paper the time for which they have prepaid. Before the time indicated expires, to insure a continuity of numbers, subscribers should remit for another year. For the convenience of the mail clerks, they will please also state when their subscriptions expire.

New subscriptions will be entered from the time the order is received; but the back numbers of either the SCIENTIFIC AMERICAN or the SCIENTIFIC AMERICAN SUPPLEMENT will be sent from January when desired. In this case, the subscription will date from the commencement of the volume, and the latter will be complete for preservation or binding.

VOL. XXXVII., No. 3. [NEW SERIES.] *Thirty-second Year.*

NEW YORK, SATURDAY, JULY 21, 1877.

**Contents.**

(Illustrated articles are marked with an asterisk.)

| | | | |
|---|---|---|---|
| Ame can beef, exportation of.. | 38 | Iron bridges | 36 |
| American children | 33 | Lacquer (53) | 44 |
| American Institute Exhibition.. | 38 | Lead pipe, manufacture of* | 31 |
| Aniline yes | 40 | Locomotive crane* | 34 |
| Balloon accident, singular | 35 | Lime wash, colored (4) | 43 |
| Bedstead, gaspipe* | 38 | Nickel, treatment of | 38 |
| Belt, cure for slipping (45) | 43 | Patents, American and foreign.. | 42 |
| Blueing iron (46) | 44 | Patents, official list of | 44 |
| Brasing (25) | 43 | Plating brass (55) | 44 |
| Buried, [illegible] centuries | 35 | Potash, method of detecting | 35 |
| Car, bul[illegible]-proof | 37 | Potato beetle, enemy of* | 36 |
| Cartridges, to prime (57) | 44 | Practical mechanism, No. 30* | 37 |
| Coloring skins (42) | 43 | Priming | 37 |
| Correspondence, Washington | 36 | Problem, the great | 32 |
| Curing Meat (41) | 43 | Renovating gilt frames (32) | 43 |
| Decisions of the courts | 41 | Safe filling (23) | 43 |
| Electric telegraphy, new system. | 40 | Science, an inexact | 32 |
| Electrical plant | 35 | Seasoning lumber (31) | 43 |
| Electro deposition, new | 40 | Shelter for straw (13) | 43 |
| Enamel (16) | 43 | Shells, to polish (43) | 43 |
| Etching (52) | 44 | Smith, Nathan R | 35 |
| Filtering (2) | 43 | Steam launch, small | 33 |
| Fluting reamers (30) | 43 | Stellar spectroscope, new | 40 |
| Fleas, to exterminate (5) | 43 | Steam fire engine (7) | 43 |
| Flowers, preservation of | 41 | Stove blacking | 41 |
| French Physical Society | 40 | Swallow, instinct of | 36 |
| Fuel for cooking | 34 | Tea, how the Chinese make | 38 |
| Girder work, wrought iron | 35 | Tempering plow plates (10) | 43 |
| Glass, some properties of | 41 | Thermo-electrical battery | 40 |
| Glue heating apparatus* | 31 | Torpedo warfare* | 39 |
| Horse-collar machine* | 38 | Volcanic eruption at Hawaii* | 35 |
| Ice tongs* | 33 | Water pipe pressures | 37 |

TABLE OF CONTENTS OF
THE SCIENTIFIC AMERICAN SUPPLEMENT,
**No. 81,**
**For the Week ending July 21, 1877.**

I. ENGINEERING AND MECHANICS.—Fast Steam Launch. Designed by H. S. MAXIM, M.E. Length, 21 ft.; speed, 10 miles per hour; boiler, 26 in. long, 20 in. diameter; diameter of cylinder, 3¼ in.; stroke, 3 in.; weight of engine, 75 lbs. 5 illustrations.

Raising Sunken Vessels; read before the Institution of Naval Architects by LATIMER CLARK, C.E. A description of a submerging dock proposed by Clark and Standfield, for recovering vessels sunk in various depths and positions, and when partially imbedded in the bottom, without the delay and expense of diving. 3 illustrations.—Propeller and Propeller Shaft of the "Thetis." 1 figure.—Pump Propulsion.—Corrosion of Propellers. 3 figures.—Improved Ship's Anchor. 3 illustrations. —Steam Boilers and Engines for High Pressures; designed by LOFTUS PERKINS. 6 figures.—Bicycling. Horseshoeing.—An Improved Squeezer. By Mr. J. HEAD, M.I.C.E. 4 figures.—Another Atlantic Cable.

Spontaneous Combustion; read before the Society of Arts, London, by CHAS. W. VINCENT, F.R.S. An able exposition, clearly explaining what heat is, and how it is produced by disruption and by combination, and how spontaneous combustion results. Spontaneous firing of haystacks. The effects of fermentation. Spontaneous combustion of coal and its causes. Spontaneous combustion on ships, and starting statis ics of losses thereby. How carbon spontaneously ignites. Faraday's interesting experiments.—Flash Signals, by D. BERNE PEEBLES. 1 illustration.—Aerial Telegraphy.—Building Materials Produced in Maine.—Lithographic Stone Supply.—English Bank Notes.—The Guadalupe Mine.—A brief history of the mine; description of the lower re ions; quicksilver bonanza; the furnaces.

II. CHEMISTRY AND METALLURGY.—Cryolite and its Uses.—Chromium.—Preparation and Use in Casting Steel of Alloys of Silicon and Manganese; by SERGIUS KERN.—Metals Accompanying Iron; by M. A. TERREIL.—Phyllocyanin as a Reagent.—Pencils of Silver Nitrate.

III. LIGHT, HEAT, ELECTRICITY, ETC.—New Theory of Microscopic Vision. Observations of Professor Abbe's Experiments illustrating his Theory of Microscopic Vision. Read before the Royal Microscopical Socie y by J. W. STEPHENSON, F.R.A.S. Giving an explanation of this very probable theory and 5 experiments, 20 figures.—The effect of Inaudible Vibrations on Sensitive Flames.

IV. MEDICINE AND HYGIENE.—A New Theory of the Origin of Typhoid Fever.—The microscopic Anatomy of Vaccination.—Cure for Prickly Heat.—Pus in Hospitals.—Sick Headache.—Oxide of zinc in Diarrhœa. —Elimination of Lead in Saturnine Paralysis.—Jaundice from Pork and Beans.—Chamomile Fumes in Hay Fever.—Nitric Acid for Hoarseness.—Human Gastric Juice.—A New Discoverer of Anæsthesia.—Peculiar Appearance of Diseased Blood.—Cause of Pain.—Deafness.—Skin Grafting.—The Body in Extreme Age.—Singular Example of Lead Poisoning.

V. ASTRONOMY.—The Relative Ages of the Sun and certain of the Fixed Stars; by Professor DANIEL KIRKWOOD, of Indiana University. Read before the American Philosophical Society, April, 1877. The Chemical Theory of the sun's heat shown to be untenable. An explanation of the Mechanical Theory of the same. The sun and Alpha Centauri. 61 Cygni Sirius.

VI. GEOLOGY A D NATURAL HISTORY.—Catastrophism; by CLARENCE KING. (Continued from Supplement No. 80.)

VII. MISCELLANEOUS.—Panel Ornament, designed by J. BORMAN, and manufactured by Dankberg Brothers, Berlin. 1 illustration.

**Terms.**—SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, *five dollars*. One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, *seven dollars*. CLUBS.—One extra copy of the SUPPLEMENT will be supplied ratis for every club of five SUPPLEMENT subscribers at $5.00 each.

All the back numbers of the SUPPLEMENT, from the commencement, January 1, 1876, can be had. rice 10 cents each.

NOW READY.—The SCIENTIFIC AMERICAN SUPPLEMENT for 1876, Complete in two large volumes. Over 800 quarto pages; over 2,000 engravings. Embracing History of the Centennial Exhibition. New Illustrated Instructions in Mechanical Drawing. Many valuable papers, etc. Price five dollars for the two volumes, stitched in paper; or six dollars and fifty cents, handsomely bound in stiff covers.

Remit by postal order. Address
MUNN & CO. UBLISHERS,
37 Park Row, New York.

☞ Single copies of any desired number of the SUPPLEMENT sent to any address on receipt of 10 cents.

## AN INEXACT SCIENCE.

It seems to us that civil engineering—or at least the civil engineering practice of the past—has, if we are to credit the *dicta* of modern eminent theorists, fairly earned the above title. Here, for instance, are two important works before us, respectively dealing with two great branches of the profession, hydraulic engineering and engineering constructions. The first is entitled "The New Formula for Mean Velocity of Discharge of Rivers and Canals," by W. R. Kutter, translated by Mr. Louis D'A. Jackson, a well known authority. In the preface we are told that the whole of the old velocity formulæ of Eytelwein, Stevenson, Dubriat, Prony, and others, which have been used as "the bases of calculations of discharge for tables, which are still unfortunately believed in by the unreflecting," have no claim to general application, that, in short, said formulæ are altogether erroneous; and in some cases, tabulated velocities based thereon are "but the wildest guesses at the actual velocities." Herr Kutter's formula, founded on the experiments of D'Arcy and Bazin, Humphreys and Abbot, and others, is now absolutely correct; and the other formulæ, with the aid of which our engineering forefathers apparently managed to complete some substantial work, are proscribed.

Now also comes Dr. Weyrauch; and in the preface to his admirable work on "Strength and Calculations of Dimensions of Iron and Steel Constructions," we are told that "the methods hitherto employed in calculating the dimensions of iron steel constructions have been entirely wrong; and that the security of structures, in which their results have been applied, though with great expenditure of material, is much less than supposed." And thereupon Dr. Weyrauch gives us an excellent book, demonstrating new and absolutely correct formulæ, and also proceeds to proscribe the other formulæ which have been relied upon in the building of a great many structures in years past, structures which, unaccountable as it may appear, still manifest no inclination to fall down. Dr. Weyrauch's and Herr Kutter's formulæ are, we are given to understand, fully indorsed by the engineering profession, and, we have no doubt, with excellent reason; but we should like to know what is going to be done about all the engineering work which, in the absence of any other, must have been based on these now scouted and repudiated rules. Are we to leave standing bridges and buildings, the dimensions of every member of which has been calculated wrongly, and which are only apparently secure? Or are we to remain in passive indifference to our waterworks when the chances of their breaking down and drowning us are only fortified by rules based on the "wildest guesses?"

Seriously, and while we shall not presume to say that the two eminent engineers above quoted have proceeded a whit too far in their condemnation of the old rules, we may at least question the fact whether engineers in actual practice confine themselves so closely to theoretical deductions as these and most textbook writers would have us suppose. Indeed, we think it will be found that the average civil engineer—and we may as well include the mechanical engineer with his professional relative—will prefer his own judgment and the teachings of his own experience in matters of construction, especially if both qualities have been often successfully tested, to almost any one's theoretical *dicta*. Not that we mean to say that our engineers constantly prefer thumb rules to scientific accuracy, or dash at conclusions by guesswork. On the contrary, we think, in point of the care displayed in and the exactness of their constructions, American civil engineering structures will compare favorably with any in the world, while our mechanical appliances are already renowned for perfection of design. But we believe that, in most instances, if the constructors or designers were asked whose or which formulæ they followed, the large majority would assert that their experience had been taken as the principal guide upon which to found their own theory. A noted civil engineer—one who has constructed perhaps more railway bridges than any other man in the country—recently said that he had never used the calculus in his work in his life. Yet almost any textbook on strains and stresses teems with formulæ based on that abstruse branch of mathematics. The calculus is invaluable to the mathematician; but here at least is one engineer who takes the responsibility of figuring his strains and selecting his sizes of material without its aid.

Another instance: We have before us a letter from a very eminent experimenter upon the strength of metals, etc. He informs us that, by his recent investigations, involving an immense number of experiments, the report of which before many months will be made public, the deductions of Rankine and other authorities as to strength of chain are wholly wrong: that the stud does not increase the strength of links, and the strongest links are not made from the strongest bars, besides other somewhat startling deductions. Theoretically at least, then, all our chain cables have been made under erroneous rules; practically, however, they have served their purpose. It cannot be conceived that new theories in chain construction, or in any other branch of science involving constructive work, can cause materials to do more than is expressed in the latter phrase.

The columns of this journal show perhaps most clearly how much our improved forms of machinery are due to constructive skill based on practice. Take any mechanical invention, adapted by its originator after long study to achieve a certain purpose, and observe its form as first published on these pages. Search for that device five years afterwards, and it is hardly recognizable. Experience has called for more metal here, less there. Actual tests have shown what modifications of the machine are necessary to render it most efficient in its duty; and these modifications have suggested others, and so on. It can be safely stated that, in hundreds of our best mechanical appliances, their capabilities were not known until they were tested. Furthermore, the rule, in nine cases out of ten here (we know it is not so abroad), is that a mechanic wanting a new special machine for a special purpose will design the apparatus which his experience tells him is best adapted to his ends, and test it to determine its duty, search for failings, improve it, and so work up to the desired point; and this he will do while his brother of the Old World is puzzling over his drawing board to discover how, by Greek letter formulæ and the differential calculus, he can produce a device that will give the wished-for results on the first trial. We have a profound respect for theory, for it should be the essence of a vast amount of practice. But if we had a bridge to build, we would prefer the man who had already built half a dozen successfully to the theorist and mathematician who had constructed none except on paper in his study, and those according to formulæ which may be repudiated a year hence.

## THE GREAT PROBLEM.

That the earth was at one time incapable of sustaining life, and that at some time in the course of events life began to be, no one doubts for a moment. It is also pretty generally admitted among scientific men that the beginning of life was in all probability a natural event; and that the earlier forms of life did not embrace the more complex types now existing, but were of simpler structure, perhaps not unlike the lowly organisms now studied under the microscope.

Here the question arises: Was the beginning of life a phenomenon single and unique, and are the bacteria of today the unaltered descendants of the earliest forms of life? Or may life have began, and may it still begin, at any time by the concurrence of suitable conditions? This is by all odds the most important question now before the scientific world; and curiously the most strenuous opponents of the theory that life may begin now as well as ever, are found among those who, like Professor Tyndall, believe life to have been derived originally from purely material combinations. That matter should have lost any of its intrinsic "power and potency" in the course of ages seems altogether unlikely; so we must infer that the active opposition of the leading exponents of evolution to the theory of the recent evolution of life *de novo*, arises from pure loyalty to truth experimentally determined. Spontaneous generation is the logical outcome of evolution; but they will not admit the fact until it has been demonstrated beyond the possibility of a doubt.

At first thought this might seem to be a question of speculative interest merely: but it is far more than that. Some of these minute and apparently primary forms of life are among the most potent factors of human health and disease, and of the health and disease of the animals and plants most intimately connected with our sustenance and general wellbeing. Even the air we breathe seems at times to be contaminated by their presence; our blood is poisoned by them, and the struggle for existence rises or degenerates into a struggle against them. It is no wonder then that the question of their origin is one of the highest practical as well as popular interest, or that the foremost men in biological science have essayed its solution.

Years of critical investigation have stripped the problem of many confusing and irrelevant conditions until it stands nakedly thus: Can we take matter which contained no life, perfectly isolate it from possible impregnation, and subject it to conditions under which it will bring forth objects that live and multiply? If so, what kind of matter must be used, and what are the conditions favorable to such origination of life?

Thanks to the labors of many of the acutest minds in experimental science—among them Pasteur and Pouchet, in France; Huitzinga, Cohn, Klebs, Bilbroth, in Holland, Austria and Prussia; Mantegozza, Cantoni and Oehl, in Italy; Bastian, Lister, Sanderson, Tyndall, Dallinger and Roberts, in England; Wyman and others in our own country, with any number of less eminent investigators—the primary conditions of the problem have been satisfactorily mastered. It is admitted by all that by subjecting matter to a sufficiently high temperature it can be entirely freed from life and life germs. It is admitted that the all-pervading germs of life cannot pass through a sound plate of glass; consequently any substance to be tested can be kept perfectly isolated by hermetically sealing the vessel containing it. Other successful methods have been employed; but this is the most exact ing, and is beyond question or suspicion when used with reasonable care. It is admitted also that the temperature at which putrefaction ordinarily takes place most actively is a proper temperature at which to keep the fluids under examination; and fluids must be used since they are the natural habitat of bacteria.

The question, What is a killing temperature? has been very hard to settle; that is, a temperature high enough to surely destroy life, yet not so high as to endanger the chemical composition of the solutions to be tested. A comparatively low temperature suffices to kill bacteria, and so far as positively known, bacteria multiply only by fission. They may, however, multiply also by means of invisible germs; and since many germs are known to withstand a higher heat than the developed forms, a higher temperature than suffices to kill bacteria must be insisted on in all experiments in this