Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, NEW YORK.

TERMS FOR THE SCIENTIFIC AMERICAN.

(Established 1845.)

One copy, one year, for the U. S., Canada or Mexico.....$3 00
One copy, six months, for the U. S., Canada or Mexico..... 1 50
One copy, one year, to any foreign country belonging to Postal Union 4 00
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, corner of Franklin Street, New York.

The Scientific American Supplement

(Established 1876)

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, for the U. S., Canada or Mexico. $6.00 a year to foreign countries belonging to the Postal Union. Single copies 10 cents. Sold by all newsdealers throughout the country. See prospectus, last page.

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, to one address in U. S., Canada or Mexico, on receipt of *seven dollars*. To foreign countries within Postal Union *eight dollars and fifty cents a year.*

Building Edition of Scientific American.

(Established 1885.)

THE BUILDING EDITION OF THE SCIENTIFIC AMERICAN is a large and splendidly illustrated periodical, issued monthly, containing floor plans and perspective views pertaining to modern architecture. Each number is illustrated with beautiful plates, showing desirable dwellings, public buildings and architectural work in great variety. To architects, builders and all who contemplate building this work is invaluable.

Single copies 25 cents. By mail, to any part of the United States, Canada or Mexico, $2.50 a year. To foreign Postal Union countries, $3.00 a year. Combined rate for BUILDING EDITION with SCIENTIFIC AMERICAN, to one address, $5.00 a year. To foreign Postal Union countries, $6.50 a year. Combined rate for BUILDING EDITION, SCIENTIFIC AMERICAN and SUPPLEMENT, $9.00 a year. To foreign Postal Union countries, $11.00 a year.

Export Edition of the Scientific American

(Established 1878)

with which is incorporated "LA AMERICA CIENTIFICA E INDUSTRIAL," or Spanish edition of the SCIENTIFIC AMERICAN published monthly, uniform in size and typography with the SCIENTIFIC AMERICAN. Every number contains about 50 pages, profusely illustrated. It is the finest scientific, industrial export paper published. It circulates throughout Cuba, the West Indies, Mexico, Central and South America, Spain and Spanish possessions—wherever the Spanish language is spoken. THE SCIENTIFIC AMERICAN EXPORT EDITION has a large guaranteed circulation in all commercial places throughout the world. $3.00 a year, post paid to any part of the world. Single copies, 25 cents.

MUNN & CO., Publishers, 361 Broadway, New York.

☞ The safest way to remit is by postal order, express money order, draft or bank check. Make all remittances payable to order of MUNN & CO.

☞ Readers are specially requested to notify the publishers in case of any failure, delay, or irregularity in receipt of papers.

NEW YORK, SATURDAY, MAY 30, 1896.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

SCIENTIFIC AMERICAN SUPPLEMENT

No. 1065.

For the Week Ending May 30, 1896.

Price 10 cents. For sale by all newsdealers.

OUR PRIZE ESSAY COMPETITION.

We take much pleasure in announcing that Judge A. P. Greeley, of the Patent Office, Washington, Prof. R. H. Thurston, of Cornell University, and Prof. R. S. Woodward, of Columbia University, have consented to act as judges in our forthcoming prize essay competition. Their names are so well and honorably known in the world of science and art as to need no introduction to our readers, and intending competitors will feel that the wide experience and ripe attainments of these gentlemen are a guarantee that their interests will be in safe and discriminating hands.

Prof. R. S. Woodward, who is the Dean of the School of Pure Science and Professor of Mechanics, Columbia University, was for many years engaged in the Geological and Lake Surveys of the United States Government, during which time he formed one of the Transit of Venus Commission. His voluminous contributions to scientific and technical literature during the past twenty years cover a wide range of subjects, and have won for him a high reputation among the scientific societies of both hemispheres.

Prof. R. H. Thurston, Director of Sibley College and Professor of Mechanical Engineering, Cornell University, was for many years Professor of Engineering at the Stevens Institute of Technology. He is a past president of the American Society of Mechanical Engineers, and his name appears upon the roll of many other engineering societies in Europe and America. Perhaps he is best known by his many works upon engineering and kindred subjects, which form a valuable part of the technical literature of this country. Judge Arthur P. Greeley, Examiner in Chief at the Patent Office, Washington, who is a lawyer by profession, has won his present high position in various competitive examinations, in which he has gained successively the position of third, second, first assistant and principal examiner. His long and varied experience in the Patent Office has given him at once a broad and detailed acquaintance with the development of the various arts in the past half century.

With the selection of a jury, the arrangements for the competition are now complete, and we trust that intending competitors will facilitate the work of these gentlemen by forwarding their manuscripts at the earliest convenient date.

THE INVENTION OF THE BESSEMER PROCESS.

Some further correspondence relating to the invention of the Bessemer process has lately appeared in the technical press, and as it comes from the pen of Mr. Bessemer himself and of one of the contemporaries and co-workers of Mr. Kelly, it is of special interest. By reference to the presidential address of Mr. Joseph D. Weeks before the American Institute of Mining Engineers, published in the SUPPLEMENT of April 25, it will be seen that among other witnesses quoted therein as testifying to having seen Mr. Kelly's experiments is Mr. John E. Fry, who was at the time a foundry moulder at the Cambria Works. Mr. Fry's testimony, as quoted by Mr. Weeks, gives some details of the apparatus used by Mr. Kelly, and describes the experiments up to the point at which "the pipe was shoved down with the blast on," and "a cover of pieces of sheet iron was laid across the top to prevent the sparks flying too freely." In his reply to the address, Mr. Bessemer complained that Mr. Fry's testimony stopped short at the very point where it became most interesting, and he claimed that the testimony of the witnesses "would have been infinitely more to the purpose if they had told us something about the way in which this metal was taken out, in what state of partial or complete solidity it was obtained," etc., and he drew the conclusion that "the absence of these facts affords very strong circumstantial evidence that Kelly never had produced homogeneous malleable iron, and had never made an ingot by his process."

The publication of the address, and Mr. Bessemer's reply, caused Mr. John E. Fry to write an explanatory letter to Mr. Bessemer, which has been widely published in the English technical press. The letter, with Mr. Bessemer's comments upon it, will be found in the current issue of the SUPPLEMENT.

Mr. Fry, who is now the manager of the Cambria Steel Works, states in this letter that the evidence which was quoted in the presidential address was extracted from some "personal recollections" which he furnished to Mr. Weeks in the course of a two hours' conversation on the subject of the early Kelly experiments, a conversation which took place at Mr. Weeks' request. In connection with this interview, he furnished Mr. Weeks with a drawing of Mr. Kelly's apparatus made in 1858, and also with a copy of an article which he had written in 1894, entitled "The Bessemer Industry: Johnstown's Contribution to it." He goes on to say: "My interview with Mr. Weeks gave him vivid personal recollections antagonistic to his views. The drawing proved that, as late as the year 1858, Mr. Kelly's experiments and ideas had not progressed beyond the operation of the 'finery fire,' and the printed article gave what I believe to be the very first public announcement of Mr. Kelly's absolute failure to accomplish anything that would give ground to his claim of being the inventor of the pneumatic process of converting cast iron into its malleable products." He further says of the Johnstown publication above referred to, "In it I made as plain as circumstances would warrant that Mr. Kelly was copying your methods as fully as his limited sources of information enabled him to do, and that he was doing only that."

The publication of this very timely letter can have but one effect as far as the evidence in favor of Mr. Kelly's claims is concerned. It shows that whatever other testimony may be adduced in his favor, the evidence of the man who was told off by the Cambria authorities to assist Mr. Kelly is emphatically against him. It is scarcely necessary to add that Mr. Fry has completely cleared himself of any suspicion of giving a distorted or partial statement of the facts as far as he knew them.

It is to be hoped that, with the publication of Mr. Fry's letter, the public has heard the last of this long-buried question. It is the great value of the testimony of Mr. Fry that has led us to bring it again before our readers, coupled with the conviction that the full testimony will serve to settle any doubts which may have been aroused as to the historical facts connected with one of the greatest inventions of the century.

MOLECULAR ANNEALING.

Thanks to the investigations of Mr. Alexander E. Outerbridge, Jr., the ghost of the old theory of the crystallization of cast iron under the influence of repeated shocks is "laid" forever. According to this gentleman, not only is cast iron not weakened by repeated blows, but it is actually and considerably strengthened thereby. Mr. Outerbridge, who is now chemist to the William Sellers Company, of Philadelphia, noticed some years ago, when he was engaged in metallurgical work in a car wheel factory, that "chilled cast iron car wheels rarely cracked in ordinary service after having been used for any considerable time; if wheels did not crack when comparatively new, they usually lasted until worn out or condemned for other causes." Although this curious fact was noticed, its real explanation was not discovered at the time, the cracking of new wheels being attributed to imperfect annealing in the oven.

In 1894 Mr. Outerbridge had occasion to test some cast iron bars for the Sellers Company. Before testing they were placed in a tumbling barrel to be cleaned, and when they came to be broken in the transverse testing machine Mr. Outerbridge "noticed with surprise that the average strength of the entire series was considerably higher than was usual with similar iron mixtures." A careful inquiry was made to ascertain the cause of the difference; but it was found that the machine was in good order and that the metal was of normal composition. The next step in the investigation was to cast twelve bars from one pattern and one runner. Six of these were cleaned by the tumbler and six with a wire brush. Upon breaking the twelve bars in the machine, it was found that those which had been subjected to four hours' incessant concussion in the tumbler were ten to fifteen per cent stronger than the other bars! Various explanations were offered and proved by experiment to be false, until Mr. Outerbridge suggested that the increase of strength might be due to the "mobility of molecules of cast iron at ordinary temperature when subjected to repeated shocks." This theory was tested by subjecting each of six new cast iron bars to 3,000 taps with a hammer upon one end. When they were broken in the machine they showed the same increase of strength as the bars that had been cleaned in the tumbler. He reasonably concluded that he had proved his case, and the engineering world is certainly indebted to him for the discovery of a most remarkable property of cast iron.

The details of Mr. Outerbridge's experiments were given in a paper which he read before the Pittsburg meeting of the American Institute of Mining Engineers. He claims that while it is very well known that the annealing of castings increases their strength by releasing the strains set up in cooling, it is not known that "the molecules of cast iron are capable of movement (for they do not touch each other) without the necessity of heating the castings, and they can thus rearrange themselves in comfortable relation to their neighbors and relieve the overcrowding near the surface of the casting; or, in more technical words, a molecular annealing may be accomplished at ordinary temperatures which will release the strains in the castings, precisely as does annealing by slow cooling in heated pits or ovens."

In addition to the transverse tests already enumerated, a series of impact experiments by means of a falling weight were carried out.

"Six of the 1 inch square test bars, cleaned with the wire brush, were broken upon the impact machine by dropping the weight from a sufficient height to break each bar at the first blow; the six companion bars, also cleaned with the brush, were then in turn sub-

jected to blows numbering from ten to fifty each of the same drop weight, falling one-half the former distance, these blows being insufficient to break the bars. The weight was then permitted to fall upon each of these bars in turn, from the height at which the six bars previously tested were broken on first blow. Not one bar broke. Two, three, six, ten, and in one case fifteen blows of the same drop, from the same extreme height, were required to break these bars. In another similar case the weight was dropped once from the former maximum height, then raised by inches until four more blows, each fall being one inch higher than the last, were delivered before breaking the piece. Subsequent tests gave still greater gains in strength."

In conclusion it was pointed out that "molecular annealing" differed from annealing in the oven in that it cannot change the chemical constitution in any way; and it is merely claimed that "every iron casting when first made is under a condition of strain, due to difference in the rate of cooling of the metal near the surface and that nearer the center, and also to difference of section; that it is possible and practicable to relieve these strains by tapping repeatedly the casting, thus permitting the individual metallic particles to rearrange themselves and assume a new condition of molecular equilibrium."

It is suggested in conclusion that all castings which are to be subjected to sudden and severe strains in actual service should never be tested at first up to anything like their full capacity. This applies to such castings as steam hammer frames, housings for rolls, and possibly to cast steel and all metal castings. The influence of shock upon the various forms of castings other than iron is now being made the subject of experiment.

Celestial Sights in June.

BY GARRETT P. SERVISS.

This is the month of the summer solstice. In June the sun attains its greatest northern declination, and the astronomical summer begins. The event occurs about 5 o'clock in the afternoon of the 20th, Eastern standard time. In the course of the month the sun will cross the Milky Way from Taurus to Gemini. During the first week the celestial "Bull," himself invisible in the blaze, will carry the god of day upon his "golden horns." At the end of the third week the sun will be received by Gemini, and at the time of the solstice will be close to the wonderful star cluster called M 35. Looking at the noonday sun in the middle of the month, it will be interesting to remember that Orion, with all his splendors of belt, sword, double stars, clusters and nebulæ, which made so brilliant a display during the winter evenings, is now hidden by the blue screen of the atmosphere just underneath the place occupied by the sun, and that if the latter should be suddenly extinguished, the surprising spectacle would be presented of the great luminaries of winter glittering through the warm summer air.

The majority of the planets are too near the sun, or too inconveniently situated, to be well seen this month. Mercury is low in the west, in the constellation Taurus, just after sunset at the opening of the month, but on the 10th it passes between us and the sun, emerging as a morning star after that date.

Venus is also in Taurus as a morning star, and at the beginning is situated about half way between the Hyades and the Pleiades. She is moving eastward and gradually gaining upon the sun, which she will overtake, in the center of Gemini, on the 8th of July. After that date she becomes an evening star.

Mars makes a long excursion through the constellation Pisces, passing into Aries at the end of the month. But, although it rises not long after midnight, it cannot yet be studied to advantage, even with the aid of a powerful telescope, because its distance from the earth is fully a hundred million miles greater than when the planet is in opposition.

Those who wish to see Jupiter during the present season must make haste. The great planet is sinking rapidly toward the western horizon, and, by the end of the month, will set as early as 9 o'clock. It is in Cancer, moving slowly toward the southeast, but it will not pass out of that constellation before disappearing from the evening sky. I append a few phenomena of its satellites:

June 2, 8:36 P. M. Satellite III begins a transit of the planet's disk.—9:05 P. M. The shadow of III enters upon the disk.—9:06:08 P. M. Satellite IV disappears in eclipse.—9:25:58 P. M. Satellite II reappears from eclipse.—June 16, 8:26 P. M. Satellite I begins a transit of the disk.—9:18 P. M. The shadow of I enters upon the disk.

Saturn is still near the star α in Libra, and during the month will move slowly westward. It is finely placed for telescopic observation, crossing the meridian about 9 P. M. in the middle of the month. A singular splitting up of the central bright ring into four parts, separated by exceedingly narrow divisions resembling faint hair lines, has been lately noticed in Europe. Similar phenomena have been observed in this ring at various times as far back as the days of Herschel. The most natural explanation of them seems to be that they are due to recurring variations in the disturbing attractions of the planet's satellites. These new divisions of the rings are hopelessly beyond the power of ordinary telescopes, but Ball's division, which always exists, can easily be seen.

An excellent opportunity is now presented for seeing some of Saturn's satellites. A good 4 inch telescope, under favorable conditions, will show five of them. The only certain way to distinguish between the satellites and small stars which may be near the planet is to carefully observe their motion from night to night. The fainter satellites can only be seen when near their greatest elongations from the planet. In order to facilitate their recognition I give the approximate times of elongation for the five satellites most easily seen, beginning with the nearest to the planet.

Tethys, eastern elongation, June 15, 10:26 P. M.; June 17, 7:50 P. M.

Dione, eastern elongation, June 12, 10:38 P. M.; June 23, 9:20 P. M.

Rhea, eastern elongation, June 1, 9:32 P. M.; June 10, 10:09 P. M.; June 19, 10:56 P. M.

Titan will be on June 3 east of the planet; on June 7 south, i. e., above as seen with an inverting eye piece; on June 11 west, and on June 15 north.

Japetus from the beginning of the month until the 13th will be seen moving eastward from the planet; after the 13th it will approach the planet, coming into conjunction with it on the south the 1st of July.

Uranus is in Libra, eight or nine degrees east of Saturn, but although visible to the naked eye, only the trained observer is likely to see it without optical aid. A strong opera glass will suffice. Those who care to see Herschel's planet can pick it up in this way: Find in Klein's Star Atlas, Map X, the little star marked "22," and, by the aid of the more conspicuous surrounding stars, locate it in the sky. Uranus, on June 3, will be just east of "22," and in the course of the following three or four days will pass close to the north of that star, moving in a direction somewhat north of west. A correct eye will easily detect the effect of the motion from night to night.

Neptune, in Taurus, comes into conjunction with the sun on the 7th.

June opens with a waning moon, which reaches last quarter on the morning of the 3d. The June new moon comes on the morning of the 11th; first quarter on the morning of the 18th, and full on the morning of the 25th. The moon will be nearest the earth on the night of the 20th and farthest on the morning of the 5th.

Following are the dates of the moon's planetary conjunctions for June:

Mars on the 5th, Venus and Neptune on the 10th, Mercury on the 11th, Jupiter on the 14th. This conjunction will be interesting. It occurs about 4:12 P. M., and with a telescope the observer will be able to see Jupiter in full daylight less than a degree south of the crescent moon. On the 21st the moon meets Saturn, and on the 22d Uranus.

Taurus, besides carrying the sun this month, will gain additional distinction from the maneuvers of the three planets, Mercury, Venus and Neptune, which will meet and pass (and in the case of Mercury and Neptune, meet and pass a second time) between his horns. Unfortunately, owing to the presence of the sun, these planetary conjunctions will not be visible. Their dates are: Mercury and Neptune, 14th, 7 P. M.; Mercury and Venus, 15th, 2 A. M.; Venus and Neptune, 15th, 5 A. M.; Mercury and Neptune, second meeting, 30th, 2 A. M.

The possessor of a telescope will find June presenting great attractions among the double stars. About 10 P. M. in the middle of the month Antares, in the Scorpion, will be well placed east of the meridian, and, with a steady atmosphere and keen eye, a 3½ inch glass may show the minute bright green companion of the great red star. A 4 inch, under good conditions, is certain to show it. The star β in the Scorpion is an easy and beautiful object with the smallest telescope. Farther east the Milky Way clusters in Sagittarius, and Scutum Sobieskii will be seen rising, and with nothing more powerful than a field glass one may catch a glimpse of their gorgeous sun swarms. Overhead at the same hour will be found the Northern Crown, and further east Hercules and Lyra, both crowded with beautiful telescopic objects, while dipped in the Milky Way below them appears the Northern Cross, with the exquisitely colored double Albireo in its foot. I have separated the orange and blue components of this star with a simple pocket telescope.

Ruling Diffraction Gratings.

"Rowland's grating" is made by ruling parallel lines on a concave plate of what is known as speculum metal. This metal is an alloy of two parts copper and one part tin. The parallel grooves are made with a delicately adjusted diamond point. The machine on which the grating was made was manufactured after eighteen months' hard work by Theodore C. Schneider, the machinist at Johns Hopkins University, from the designs of and by processes invented by Prof. Rowland, who was constantly at hand to direct every movement. This machine is in a dark vault under the laboratory. When a "grating" is being made, it runs night and day. The vault is locked, and no one is allowed to enter it, for the machine is so sensitive that the temperature of a human body would disarrange it. When a new diamond point is being tested, as is now the case, Prof. Rowland will permit a few people to visit it. Sir William Thomson, the Earl of Rosse, Lord Rayleigh, Prof. Ball, Astronomer Royal of Ireland, the late Prof. Helmholtz, of Berlin, Prof. Mascart, of Paris, and Prof. Lemstrom, of Sweden, are among those to whom this courtesy has been extended. The motive power of the machine is a hydraulic engine. The water is kept at a constant height in a tank near the roof, to insure unvarying speed. It is driven by a belt attached to a solid brass driving wheel on the machine. A crank is turned by the same on the other end of the shaft. This crank moves the carriage that conveys the diamond point back and forth over the surface of the "grating" or plate. This carriage rests on two steel ways, which are flat on top and slanting slightly outward, so that there are three points on one way or rail on which the carriage rests. These "ways" are ground so as to make them as nearly accurate as possible. But they cannot be made perfect, for Mr. Rowland tested them with a microscope and found that they were "out"—that is, not exactly perfect—by one fifty-thousandth of an inch. He did not attempt to improve them.—Appleton's Popular Science Monthly for May.

The National Electrical Exposition.

EDISON'S X RAY EXHIBIT, MOORE'S ELECTRIC DAY LIGHT, PHOSPHORESCENT DIAMOND.

One of the greatest attractions of this varied and interesting exhibition has been Mr. Edison's arrangement for the examination by every one of the skeleton of their own hands by means of the X or Roentgen rays. An improvised curtained room about twenty feet square is provided, illuminated by two red incandescent electric lights. On a platform in one corner is arranged a vertical fluorescent screen eighteen inches square of a composition best adapted to be affected by the rays, and fixed at a height above the floor of about five feet. Behind the screen about eight inches is a frame or screen of wood having a square aperture of about six inches. Just back of this is the vacuum Crookes lamp, or rather Edison's improved lamp. Lower down and to one side on a box is a Bunsen gas burner casting a bluish light upon the operator standing close by in his shirt sleeves.

The effect on entering the darkened chamber is somewhat weird, inasmuch as the blue light of the Bunsen burner reflecting from the white sleeve of the operator produces the impression that one is observing an X ray view of a human arm.

Back of the operator is the induction coil, and in another adjoining room is the interrupter. Directly in front of the fluorescent screen on the floor were two iron rails, between which the procession of two hundred or more persons passed two at a time, stopped, and were told by the attendant to place their hands behind the screen and then to watch as the operator turned on the current. As he did so, the current being on perhaps three seconds, the skeletons of the fingers were clearly observed. Exit was made at the other end of the room. Each time the current is turned on, a miniature fog horn sound is heard all around the place. It is reported that a man who had carried a shot in his hand, which could not be located by his physician, was among the procession of persons, and instantly saw, when the X rays illuminated his hand, that the shot was between his second and third fingers. The opaqueness of gold rings on the finger is very marked as compared with that of the bones.

Half hourly lectures were given illustrating on the screen many curious X ray shadowgraphs. Another attraction of interest was Mr. D. McF. Moore's daylight electric vacuum tubes, fitted up in a curtained room. The light is so much more diffused than the ordinary arc or incandescent light that it does not appear to be as bright to the eye, but photometric tests, we believe, prove it to be so. Many visitors crowded to see this. Tiffany & Company, through Mr. George F. Kunz, exhibited a peculiar phosphorescent diamond. In a darkened chamber, the light of an arc electric lamp passed through a blue glass lens and was allowed to strike the diamond for one or two seconds. It was then shut off, and the diamond glowed quite plainly in the dark chamber for about four seconds. The special fluorescent quality in the diamond causing that effect is termed by Mr. Kunz tiffanite.

One of the singular things missing in the exhibition was the absence of any trolley cars, their adjuncts and improvements.

A QUALITATIVE examination of the mineral species northupite from Borax Lake, California, shows that it is a double chloride and carbonate of sodium and magnesium.