olution of the barrel that carries the sensitized plate is obtained per second, and twelve photographs are taken, each with $\frac{1}{125}$ of a second exposure. All the intermediate attitudes between two photographs are lost. This is due, as well known, to the arrangement of the apparatus, this presenting the different parts of the same plate in front of a single objective, and allowing the light to enter only when the latter is immovable. It will be easily seen how much time is lost in the operation. In the system of multiple objectives, each of the latter is independent; and the time lost is considerably reduced, since the aperture in the disk always presents itself in front of an objective capable of operating properly. As the apparatus may be of any size, so the objectives may be of any number. Within the same length of time, therefore, any number whatever of photographs may be taken, it being merely a question of objectives.

FIBER PLANTS OF INDIA.

By J. W. MINCHIN, of Ootacamund, Madras Pres.

THE cultivation and treatment of fiber plants in India have occupied the attention of the Society of Arts on several occasions. The great botanist, Dr. Forbes Royle, first suggested the importance of the fiber-producing plants of India in 1854; and Dr. Forbes Watson, in an exhaustive paper before the Society, in 1860, enumerated the most important varieties; having, with the assistance of the Indian Government, collected specimens, and prepared plates representing them, which were published in the *Journal* of the Society (vol. viii., p. 448). Mr. Leonard Wray read a paper on Indian fibers in 1869, and it was again the subject of an article by Mr. P. L. Simmonds, in 1873.

Notwithstanding these frequent discussions, and the

France, Algeria, and the Southern States of America; and the attention of scientific men to some chemical or mechanical treatment has been continued.

There are now two machines and two processes that claim to treat green fibers successfully. This being accomplished, the golden hopes of Dr. Forbes Royle and of Dr. Forbes Watson, as to the future of Indian fiber, may be realized.

As the soil and climate of the hill districts of Southern India and Ceylon, with which I have been connected for the past twenty-five years, seem to me to be specially adapted to the cultivation of fiber plants, and as the introduction of any new industry is at the present time urgently wanted by the European planters settled in those portions of our Eastern empire, I have ventured to bring the subject forward again, for the purpose of urging the adaptability of this cultivation to the circumstances of the hill planters; and the fact that lately invented chemical and mechanical processes have supplied the economical and commercial prospects of success which have so long been desired.

The following fiber plants are suitable for cultivation in the hill districts of Southern India: Rhea (*Urtica utilis*), Neilgherry nettle (*Urtica heterophylla*)—these are dicotyledons, or exogenous plants, the fibers residing in their bark or bast; plantain (*Musa paradisiaca*), wild plantain, Manila hemp (*Musa textilis*), aloe (*Agave americana*), pine-apple (*Bromelia ananas*), wild pine-apple (*Bromelia sylvestris*), mooga, or bow-string hemp (*Sansevieria zeylanica*), mudar (or *Calatropis gigantea*)—which are monocotyledons, or endogenous plants, the fibers being embedded in the pulp of their roots, stems, and leaves. These and other kindred plants are indigenous to India, and can be cultivated without difficulty.

Rhea (*Urtica utilis*), *Boehmeria nivea*, ramia—China grass—is a perennial plant. In China, fields of rhea are said to last, with care and manure, for 80 to 100 years. It grows in Sikkim and Nepal at an altitude of 3,000 feet. It has been cultivated successfully on many coffee estates in India and Ceylon; but it requires rich, unexhausted soil. It grows with the greatest vigor in damp warm climates. In the islands of the Indian Archipelago it is cultivated under shade. It requires a light but fertile soil, but it must be well drained. It is propagated from the separated roots, from layers, slips, or cuttings; in this way five cuttings of grown stems can be expected in the year after planting; from seed, no crop can be expected before the third year.

M. Favier describes the plant as giving out several stems, of which the number increases in proportion to the development of the root, which forms a kind of tuft or bush. The stems are woody, and have the appearance of thick, strong rods, the height varying from 5 to 12 feet. The roots, slips, or layers should be planted 18 inches apart, and after the first crop the alternate rows should be transplanted into new fields, leaving the remainder, about 3,500 plants per acre, to spread and cover the ground. The yield in Java is said to be 44 stems per year from each stool, taken in four cuttings. Each stem in its green state weighs about 1 lb.; 100 lb. weight of green stems yield 5 lb. of a raw fiber or filament, which, by Muspratt's analysis, as quoted by M. Favier, contains 66 per cent. of pure cellulose. In the official reports to the India Office, with native hand treatment the crop is said to be 1,000 lb. of raw fiber per acre, taken in four cuttings. M. Favier states that in Algeria, 1,400 lb. of fibrous thongs was the crop per acre, as calculated by Mr. Hardy, ex-Director of the Botanical Gardens there, while in the South of France as much as 1,600 lb. of filament have been obtained to the acre.

Mr. P. L. Simmonds, in his article in 1873 (*Journal*, vol. xxi., p. 762), stated that the crop gathered in Jamaica amounted to 300 lb. per acre at each cutting, and that there had been five cuttings in the year, making the yield three-fourths of a ton per acre per year. While Mr. Bainbridge, in the discussion on Mr. L. Wray's paper, in 1869, stated that the result of his own experience in Assam was 750 lb. green nettles, which gave 45 lb. weight of fiber in each of three cuttings, making only 135 lb. per acre per year (*Journal*, vol. xix., p. 453). The yield appears to depend on soil, climate, and treatment. The properties of the rhea fiber place it in the first position among vegetable fibers; it is second to none in strength, while the fineness or attenuation of the fiber places it before flax, and it is equaled only by the pine-apple fiber. It can be used for any textile purpose, having been mixed with cotton, wool, and silk to advantage; it is in special demand for sailcloth, table napery, curtains, and tapestry; but from the very limited supply as yet available, the applications of this beautiful fiber are yet in their infancy.

Neilgherry nettle (*Urtica heterophylla*) is an annual, and can be readily grown from seed, giving its crop in about seven months. It gives a strong, white, glossy fiber, and a sample, hand cleaned, was valued at £125 per ton. The cultivation has not been tried on a commercial scale; the difficulty will be in the cultivation and collection of the crop, as the leaves and stem are armed with a most poisonous sting. It has occupied the attention of planters on the hills for many years past, but no means of treatment was known.

Plantain (*Musa paradisiaca*) is generally cultivated for its fruit; it should be planted about six feet apart, and each stem will give about 4 lb. of raw fiber, and 50 lb. of fruit per year. The fiber is fine, white, and silky; long, light, and strong. The quality depends on the mode of cultivation and treatment; but it is not so valuable as Manila hemp. The Government of India have constantly urged the value of this material for paper making; but no use has ever been made of the millions of trees grown in India for their fruit. The stems are cut down and left after the fruit is moved.

Manila hemp (*Musa sylvestris*) has been successfully grown in Wynaad and other hill districts, since 1864; but hitherto to no commercial value, from inability to treat the fiber. It is grown extensively in Manila, where 250,000 acres are planted with this staple; it has hitherto been treated only by hand, the natives preparing about 12 lb. weight of fiber per day, and receiving one-half its value for the work, the waste being so great that only about 1 lb. of fiber is obtained from each tree. Yet, notwithstanding this, the exports have amounted to 35,000 tons annually. Manila hemp is imported into Europe and America for rope making only, and is worth £20 to £60 per ton, according to quality; the crop may be taken at from 10 cwt. to 2 tons per acre, according to successful treatment.

Aloe (*Agave americana*) will thrive on any sterile, waste land, and is now common throughout India. The cultivation is being extensively carried on in Mexico, where 5,000 plants may be found in an acre. It comes to full growth in three years, and can easily be propagated from suckers. The fiber is principally used for mixture with Manila hemp in the manufacture of cordage, and is worth about £10 per ton less than Manila hemp.

Pine apple (*Bromelia ananas*) and *Bromelia sylvestris* produce a very valuable fiber. The former is cultivated for its fruit in all coffee estates, and the latter is found in large

FIG. 2.—ARRANGEMENT OF APPARATUS FOR TAKING PHOTOGRAPHS AT REGULAR INTERVALS.

A. Photographic apparatus. B. Pile. C. Metronome. C'. Clockwork. R. Ring and arbor for winding. D. Morse transmitter. E. Reservoir of mercury.

We must refer, in conclusion, to one of the most convenient of apparatus for obtaining photographs at equal intervals, this being Mr. Gaiffe's electric metronome. The current coming from the pile enters this apparatus and makes its exit through an armature provided with two points that dip alternately, according to the motion of the metronome, into a reservoir filled with mercury. From this reservoir the current goes to the apparatus.

A Morse key is interposed into this circuit and cuts it, for the following reason: Everything being arranged, the metronome is regulated to the desired velocity by means of its slide, and, when it has reached its full speed, the key is depressed so as to allow the successive currents to pass until the needle has returned to its starting-point. The current is then broken and the operation is finished.

This apparatus, which we propose to call photo-electric, is well adapted for certain medical and physiological studies, and, in the art of war, might be conveniently employed in experiments with torpedoes. The force of these weapons,

thorough knowledge that has been obtained of the value of the different principal Indian fibers, and of their cultivation and production, there has been no great commercial movement in the export of these fibers, and this is due to the difficulty that has been encountered in the treatment—the cost of preparing the fiber for the market by the native method of hand-scraping being prohibitive, and no machines or process for the economical preparation on a large scale having, until lately, been introduced.

For the valuable fibers strength and brightness of color are essential. The ordinary process of retting or fermentation in stagnant water cannot be followed.

The *Corchorus*, or jute fiber, is used principally for coarse bags, and such purposes where the strength and color of the fiber is not important. It can be produced at a very cheap cost; the cultivation of an acre of jute is estimated at Rs. 10 for the labor, and about half a ton of fiber is the usual crop; while by the retting process, one man can prepare for market about two cwt. of fiber in the day. The culti-

FIG. 3.—PHOTOGRAPHS TAKEN WITH SAME TIME OF EXPOSURE, BUT AT UNEQUAL INTERVALS.

in fact, is studied by measuring the column of water that is lifted by their explosion, and the data that permit of obtaining this result are due to instantaneous photographs taken at equal intervals by different apparatus. In practice this arrangement gives rise to difficulties and errors that might be suppressed by employing the photo-electric apparatus, maneuvered at a distance and regulated in advance.—Albert Londe, in *La Nature*.

THE deepest sea sounding ever made was in the Pacific Ocean in 1874, near the entrance to Behring's Sea. The depth was 4,655 fathoms, and the cast was made from the United States school ship *Tuscarora*. The shallowest water in the middle of the Atlantic—731 fathoms—shows the existence of submarine mountains 10,556 feet high.

vation of jute has been taken up largely by the natives in India. The export, stated by Dr. Forbes Watson in his tables, in 1860, at 88,000,000 lb., had amounted in 1874 to 560,000,000, or seven-fold in the fourteen years. For the more valuable fibers this retting process is not available; a man can prepare only 5 lb. to 12 lb. of rhea or Manila hemp fiber in a day by hand-scraping, while the waste is enormous.

The necessity for some mechanical treatment has been long recognized. In 1872, the Government of India offered a reward of £5,000 for any machine that could separate rhea fiber in a green state, at a cost not exceeding £15 per ton. The conditions were not fulfilled, but a reward of £1,500 was given to Messrs. Greig, for relatively good results. The reward has since been withdrawn. The cultivation of rhea has now been successfully introduced into the South of

quantities in all the jungle swamps in the hill districts. The fiber is valued at £45 to £55 per ton.

Bow-string hemp (*Sansiveria zeylanica*) can be propagated on almost any soil, from the slips which issue in great abundance from the roots; it is perennial; the wild leaves are from 12 to 16 inches long, but under cultivation attain 3 to 4 feet. Dr. Roxburgh estimated that an acre of land would produce three-quarters of a ton of clean fiber.

Mudar tam, zercum (*Calotropis gigantea*) is common on all waste places in India. Mr. G. W. Strettel, of the Indian Forest Department, in his pamphlet, "A New Source of Revenue for India," published in 1878, urges the value of this product on the attention of the Indian Government. It comes to maturity in a year, is perennial, and requires no care. Mr. Strettel estimates the cost of bringing an acre into cultivation, planting 4 feet apart, at £2 9s. 8d., after which the only recurring expense would be for harvesting and treatment. He estimates that it will yield a crop of from 5 to 7 cwt. per acre yearly, and the fiber is pronounced equal to good flax, and therefore worth £40 to £50 per ton.

The treatment of green fiber has now been successfully accomplished by the following machines and processes:

1. The machine of Messrs. Deeth & Ellwood, of which over one thousand are now in use, for extracting fiber from all kinds of aloe, plantain, and pine apple, etc., in Mauritius, Canary Islands, Africa, etc. It is almost the only machine in use for extracting Henquin fiber or Sisal hemp, and Ixle or wild pine apple fiber, in Central America, of which 17,000,000 lb. weight are now exported annually. It is being tried in Manila for the treatment of Manila hemp. The jet of water which acts as an elastic cushion on which the fiber is beaten to clear it of hoon and useless particles, acting also most satisfactorily in removing the gummy matter which causes the principal difficulty in the treatment.

2. An ingenious invention of M. Roquet, a Frenchman, for crushing and scutching vegetable fibers at one operation, which has been patented by Mr. W. M. Adams in this country and elsewhere. It treats all kinds of dry fibers most thoroughly, and has also successfully treated green rhea fiber from Kew Gardens.

3. M. Favier, a Frenchman, has suggested a process of treatment for rhea fiber, by steaming the green stems in the field. This enables the easy decortication of the bast by cheap hand labor, at a very small expense, and saves the cost of carriage of the woody portion of the stems, these being used for the fuel of the boiler that creates the steam. The stem ashes can be at once returned to the field as manure, together with the leaves and waste, so that only the fiber itself is removed from the soil; by this process it is calculated that the fiber thongs can be obtained at a cost of 80s. per ton.

4. The process which is known as Ekman's patent, for the manufacture of cellulose or ultimate fiber from raw fibers, by treatment with the bisulphate of magnesia. This process consists in boiling the fibrous substance under a pressure of 90 lb. of steam, in water containing sulphurous acid in combination with sufficient magnesia to prevent the oxidation of the organic matter. This chemical treatment produces an ultimate fiber from the rhea plant, which is worth £168 per ton or three times the value of the best cotton.

Seeing that it takes 100 lb. of green rhea stems to make 5 lb. of raw fiber or filament, worth at the rate of £45 per ton in the English market. M. Favier's steaming process, which saves the carriage of the woody portion further than the field in which it is grown, is an economical consideration of the highest importance.

This raw fiber or filament, after treatment in M. Ekman's boilers, is reduced from 5 lb., worth at the rate of £45 per ton, to 3½ lb. of ultimate fiber, worth £168 per ton. When this process is undertaken by the grower in India, as soon as possible after cutting and decortication in the field, the fiber is saved from the damage that is constantly going on from fermentation, as long as the tannic gum is attached to it; it being impossible thoroughly to dry the fiber while this gum remains. There is no trouble in at once drying and packing the ultimate fiber. The cost of carriage to the manufacturing market is reduced to a minimum, and the pure fiber is in no way damaged by pressure in packing under screw or hydraulic press. At the same time the cultivator obtains the full manufacturing value, which is otherwise intercepted by the mill men, who scutch, comb, and prepare the fiber for textile uses.

It seems that for dicotyledons, or exogenous plants, such as rhea and Neilgherry nettle, M. Favier's steaming process, in conjunction with M. Ekman's bisulphate of magnesia process, have attained the desired object, economical and thorough treatment.

For the monocotyledons, or endogenous plants, such as plantain, Manila hemp, aloe, pine apple, etc., the machines of Messrs. Deeth & Ellwood or M. Roquet are required. For the coarser fiber obtained from these plants no further treatment is necessary; these coarser fibers are used for rope making. The finer fibers, such as those obtained from the *Bromelias*, and the selected finer portions from other kinds may be advantageously treated in M. Ekman's boilers; while from the waste and inferior stuffs a paper pulp may be obtained which will be an important item in the receipts of the estate. In the cultivation of the fiber plants I have enumerated, the planters on the hill districts of South India will have varieties suited to every exigence of their soil and climate. For their exhausted fields, which are no longer suited for the cultivation of coffee, cinchona, or tea, there is aloe, mudar, or moorga available, which will flourish on the poorest and most exposed hill sides. For their low lying rich valleys, at elevations too low for coffee or cinchona, such as the lower slopes of the Ghats, the cultivation of rhea fiber can be carried on; on the level land, where plowing is possible, the Neilgherry nettle can be sown to advantage. The undrained swamps can be planted with the *Bromelia sylvestris*, and the borders of the streams and steep forest hills can be cultivated with plantain and Manila hemp.

The storehouses and water power generally found on the coffee estates that have been erected for the preparation of the coffee crops, and which are unused for nine months in the year, will supply the motive power for the scutching machinery, and drying accommodation for the fiber. It is probable that the cost of Ekman's boiling and chemical process may be too considerable for each individual planter, but some convenient central factory established in each district, or on the coast, may enable the planters to obtain the benefit of this process, on the same principle as is now in use for the ultimate preparation of their coffee. It therefore seems that good hope is afforded, that the cultivation of fiber plants may relieve the Indian and Ceylon coffee planters of much of the troubles that have befallen them, from the persistent attacks of the *Himeleia basitric*, or leaf disease.—*Journal of the Society of Arts.*

RESEARCHES ON THE IGNITION OF MIXTURES OF EXPLOSIVE GASES.

MALLARD AND LE CHATELIER chose for the investigation of this subject mixtures of hydrogen and air, and of carbonic oxide and air.

(1) *Temperature of Ignition.*—To measure this point, they employed a porcelain pyrometer, which was heated in a Perrot furnace: it was employed alternately as a thermometer and as a chamber of explosion. With a three-way tap of glass, communication could be opened with an air pump on the one hand, and on the other with the tubes leading to the air or with the gases to be experimented on. In order to measure the temperature of the pyrometer, it is first pumped empty of air and then filled with air, and its volume is measured. From this it is easy to calculate the temperature. After this has happened, the instrument has again to be pumped empty, and the gaseous mixture is then allowed to enter, when one soon becomes convinced whether or no at the temperature an explosion took place. This is known, first, by the noise; and, secondly, by a change of volume, which most gaseous mixtures undergo during explosion. Here it is assumed that the temperature of the furnace remains constant for a certain time, which, indeed, is hard to arrive at. We must therefore make two determinations of temperature—one before the experiment, the other after—and take the mean of them. The results can only be regarded as sufficiently exact when the two temperatures, thus determined, are not exceedingly far apart. With each gaseous mixture a number of series of experiments were made at temperatures which were as little removed from each other as possible. One must lie above the temperature of ignition, the other below it. The results obtained in this manner were very accordant, as the following numbers obtained for the explosion of mixtures of hydrogen and oxygen will show: First series, 540 to 555 deg.; second series, 552 to 577 deg.; third series, 550 to 560 deg.; fourth series, 557 to 562 deg.; fifth series, 539 to 552 deg.; sixth series, 552 to 557 deg.; seventh series, 552 to 559 deg. The temperature of ignition, therefore, of this mixture lay at 552 deg. In other experiments the authors have gone much further, and the work was much increased. The following determinations were made:

Hydrogen.			
(1) Hydrogen and oxygen.	(0.15 O, 0.85 H)	..	560 to 570 deg.
" "	(0.30 O, 0.70 H)	..	552 " 569 "
" "	(0.66 O, 0.33 H)	..	530 " 532 "
(2) Hydrogen and air	(0.70 air, 0.30 H)	..	552 " 553 "
" "	(0.30 air, 0.70 H)	..	530 " 570 "
(3) Hydrogen, oxygen, and carbonic oxide	(0.15 O, 0.35 H, 0.50 CO ₂)	..	562 " 592 "
Hydrogen, oxygen, and carbonic acid	(0.21 O, 0.49 H, 0.30 CO ₂)	..	560 " 595 "
Carbonic oxide.			
(1) Carbonic oxide and oxygen	(0.15 O, 0.85 CO)	..	630 " 650 "
Carbonic oxide and oxygen	(0.30 O, 0.70 CO)	..	645 " 650 "
Carbonic oxide and oxygen	(0.70 O, 0.30 CO)	..	650 " 680 "
(2) Carbonic oxide and air	(0.70 air, 0.30 CO)	..	650 " 657 "
(3) Carbonic oxide, oxygen, and carbonic acid	(0.15 O, 0.35 CO, 0.50 CO ₂)	..	695 " 715 "
(4) Carbonic oxide, air, & carbonic acid	(0.35 air, 0.15 O, 0.50 CO ₂)	..	715 " 725 "
Methane.			
Methane and oxygen	(0.70 O, 0.30 C ₂ H ₄)	..	600 " 650 "
" "	(0.30 O, 0.70 C ₂ H ₄)	..	640 " 660 "

The most remarkable result of these experiments is that the temperature of ignition of the gaseous mixture is little affected by the admixture of strange gases. The greatest variation occurs by the addition of carbonic acid to the carbonic oxide mixture; in the case of the hydrogen mixture the influence is less. From this we are driven to the assumption that the temperature of ignition of a gaseous mixture is affected by the products resulting from the explosion. In the case of mixtures of methane and air this method of investigation cannot be used, because the volume of the gas is not altered, and no such considerable explosion takes place that it can be observed outside the pyrometer. The authors therefore endeavored to determine the ignition point in this instance by passing the mixed gases through a porcelain tube in a furnace and placing an air thermometer as close as possible to it. The results of this experiment vary considerably—between 600 and 750 degrees. In any case, the point of ignition in this instance lies below 750 deg., and probably about 640 deg. This result shows that the assumption that the gas exploding in mines explodes at 1000 deg. cannot be maintained. It had already been shown by Davy that it is not possible to explode the mixture with a white hot rod, and he held that flame was absolutely necessary to accomplish it. The authors find that the mixture always explodes at about 800 deg. in a pyrometer after the lapse of some time, while hydrogen and oxygen always go at once. In Davy's experiment the heat of the rod caused a circulation of the gases, which hindered the continuous action of the high temperature on the gaseous mixture. If in place of the iron rod an inverted iron crucible be employed, ignition always takes place, even when the iron is only red hot, because the gas remains sufficiently long in contact with the hot metal in the hollow of the vessel. The authors point out the application of this fact to certain mining questions.—*The Engineer.*

THE STANDARD OF LIGHT.

A DISCUSSION respecting the choice of a standard light for photometrical purposes was recently held at a meeting of the French Societe d'Encouragement, when M. Felix Le Blanc, a member of the council, made a communication respecting the researches now being conducted on the subject. He observed that the candles generally used in England and Germany vary greatly in intensity, and are of comparatively feeble illuminating power; while the Carcel lamp used in France, although giving a very constant light, is not so powerful as might be desired for some purposes. The "Star" candles, manufactured in France, were formerly equivalent to one-seventh of a Carcel; but they have now fallen to one-eighth of a Carcel. M. Le Blanc valued the English standard candle at one ninth of a Carcel; with a variation of 14 or 15 per cent. between different samples. He also valued the German candle at one-sixth of a Carcel. M. Le Blanc considered, in view of the difficulties and chances of error attending the adoption of other standards, that the Carcel lamp is, on the whole, the best. The President of the Society, in commenting upon the preceding communication, remarked that the International Commission of Electricians sought a more powerful light than the Carcel; and

that if this condition is to be deemed essential, platinum in the state of fusion is the only luminous source obtainable. A square centimeter of this metal, observed at the moment of solidification as proposed by M. Violle, gives the light of about 7 or 8 Carcels. Melted silver, upon which M. Violle at first experimented, gives a very feeble light, just sufficient to enable the fact to be noted that during the time of solidification heated metals emit light-rays of constant intensity. M. Peligot, Secretary of the Society, observed that the fabrication of the "Star" candles has been sensibly altered since their introduction, to the diminution of their luminous value. He also complained of the high cost of Carcel lamps, now that their manufacture has become a specialty; but, in reply, M. Le Blanc said that very good moderator lamps, specially constructed for photometrical use, could be obtained at a cheap rate.

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, \$5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

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

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, \$2.50, stitched in paper, or \$3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, \$7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,

261 Broadway, New York, N. Y.

TABLE OF CONTENTS.

	PAGE
I. CHEMISTRY.—Researches on the Ignition of Mixtures of Explosive Gases.....	6502
II. ENGINEERING AND MECHANICS.—The Riverdale's Boilers.....	6496
With several illustrations taken from the burst boiler.....	6497
Improved Drilling machine.—With engraving.....	6497
Gaubert's Automatic Regulators and Pumps.—With full description and two figures.....	6497
New Locomotive.—With engraving.....	6497
III. TECHNOLOGY.—Champonnois's Steam Starch Plant.—Full description of processes of manufacture and apparatus used.—Several engravings.....	6490
Explosive Compounds.—Prismatic powder.—Cocoa powder.—Metamorphosis of powder.—Evolution of gun-cotton.—Nitro-glycerine.—Dynamite.—Atlas dynamite.—Blasting gelatine.—Explosive liquids.—Firing of explosive shells.....	6492
Sheet Metal Statuary.—With engraving of group for Court House, New Philadelphia, Ohio.....	6494
IV. ARCHITECTURE.—Semi-detached Houses, Eastward Ho! Estate, Felixstowe.—With engraving.....	6495
V. ELECTRICITY.—Melting Metals by Electricity.....	6495
Schmidt's Electric Lamp.—With diagram showing principle of the lamp, and several engravings showing modifications of the same.....	6496
VI. NATURAL HISTORY.—The Yellowstone National Park.—Giving a description of the country passed through by the Northern Pacific Railway and of the Park.....	6499
Fiber Plants of India. By J. W. MINCHIN.—Why the export of fiber plants has not increased.—Plants suitable for cultivation in Southern India.—Processes and machines for treatment of green fiber.....	6502
VII. MEDICAL.—Powder of Beef Blood as an Alimentary Principle.—Raw Eggs for Invalids.....	6500
Photography in Medicine.—Photo-electric apparatus.—With three engravings.....	6500
VIII. MISCELLANEOUS.—The Observatory of the International Bureau of Weights and Measures. Treating of instruments pertaining to the standard of weight.—With two engravings.....	6498
Mathematics.—British Association, Southport, 1883.—Inaugural address by ARTHUR CAYLEY.—The connection of mathematics on the one side with common life and the physical sciences; on the other side with philosophy in regard to our notions of space and time, and to the questions which have arisen as to the universality and necessity of the truths of mathematics, and the foundation of our knowledge on them.....	6498
The International Fisheries Exhibition, London.—With two large illustrations of seal hunting and boats and nets.....	6499

PATENTS.

In connection with the *Scientific American*, Messrs. MUNN & Co. are Solicitors of American and Foreign Patents, have had 38 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the *Scientific American* of all inventions patented through this agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured. Address

MUNN & CO., 261 Broadway, New York.

Branch Office, cor. F and 7th sts., Washington, D. C.