lesion will pass through gentle stages, there will be no enteric hemorrhage, and so no death from hemorrhage.

Liquor—yes, we give a little of the purest liquor in almost every, if not every, case for its proper uses, to sustain the heart, to cheer the mind, to stimulate the stomach, to diffuse the blood equally through all parts of the body, to open the pores, the greatest of all eliminators of the specific poison; but for sleep we give the remedies best and most proper for that purpose, and here opium, like life itself, is truly *donum Dei*, the best gift of God. T. J. HUTTON, M.D.

St. Paul, Minn., Sept. 5, 1892.

THE LIQUEFACTION OF GASES.

By VAUGHAN CORNISH, M.Sc., F.C.S.

THE common liquids, such as water, rock oil, mercury, and so on, can be readily converted into gases; but many of the common gases, on the other hand, for instance oxygen, nitrogen, and hydrogen, can only be brought into the liquid condition by the use of special methods and powerful agencies. Temperature and pressure are the two factors on which it depends whether a body remains in the state of gas or assumes the liquid condition. Low temperature and high pressure are the conditions favorable to liquefaction.

The history of experiments on liquefaction of gases is mainly a record of devices for producing high pressure and low temperature. Sulphurous acid gas is condensed at the temperature of an ordinary freezing mixture, or at the pressure which can be obtained by a hand-worked piston in a tube or barrel. It had been prepared in the liquid state before the year 1800 A. D. Chlorine was condensed by Northmore in 1805, but his experiments attracted little attention till years later, when Faraday had made a specialty of the liquefaction of gases, and the attention of the scientific world was drawn to the subject. Then, as usually happens, forgotten records were found of earlier work on the same lines. The later, but independent, observation by Faraday (1823) of the liquefaction of chlorine is, however, the commencement of the systematic study of the subject. Faraday has the only kind of priority which is of real importance in scientific discovery, that, namely, of being the first to make the subject fruitful, and the first to make its importance generally understood. Faraday had been experimenting on the solid hydrate of chlorine which separates out in yellowish crystals when ice cold water is saturated with chlorine gas. Sir Humphry Davy, to whom at that time Faraday acted as assistant, suggested that the crystals should be sealed up in a glass tube and heated. Davy gave at the time no reason for his suggestion, and Faraday himself did not know what to anticipate from the experiment. The crystals of the solid hydrate were placed at one end of a A-shaped glass tube, which was then closed by sealing up the glass in the blowpipe flame. The crystals being warmed to 60° F. underwent no change, but at 100° F. "the substance fused, the tube became filled with a bright yellow atmosphere, and on examination was found to contain two fluid substances; the one (chlorine water), about three-fourths of the whole, was of a faint yellowish color, having very much the appearance of water; the remaining fourth was a heavy bright yellow fluid, lying at the bottom of the former without any apparent tendency to mix with it." At 70° F. the pale portion congealed (*i. e.*, the hydrate separated out), although even at 32° F. the yellow portion did not solidify.

Heated up to 100° F., the yellow fluid appeared to boil and again produced the bright colored atmosphere. It was found that by heating to 100° F. the yellow liquid (fluid chlorine) could be distilled from the pale colored liquid (chlorine water) so as to get them in different limbs of the bent tube. "If, when the fluids were separated, the tube was cut in the middle, the parts flew asunder as if with an explosion, the whole of the yellow portion disappeared, and there was a powerful atmosphere of chlorine produced; the pale portion, on the contrary, remained and when examined proved to be a weak solution of chlorine in water with a little muriatic acid."

The paper from which the above extracts are taken was read before the Royal Society by Sir Humphry Davy in 1823. In a note at the end of Faraday's paper, Davy says that "in desiring Mr. Faraday to expose the hydrate of chlorine to heat in a closed glass tube, it occurred to me that one of three things would happen, that it would become fluid as a hydrate, or that a decomposition of water would occur (forming hydrochloric acid), or that the chlorine would separate in a condensed state." Further on he remarks, "I cannot conclude this note without observing that the generation of elastic substances in close vessels, either with or without heat, offers much more powerful means of approximating molecules than those dependent upon the application of cold, whether natural or artificial, for as gases diminish only about $\frac{1}{10}$ in volume for every degree of Fahrenheit's scale, beginning at ordinary temperatures, a very slight condensation only can be produced by the most powerful freezing mixtures, not half as much as would result from the application of a strong flame to one part of a glass tube, the other part being of ordinary temperature, and when attempts are made to condense gases into fluids by sudden mechanical compression, the heat instantly generated presents a formidable obstacle to the success of the experiment, whereas in the compression resulting from their slow generation in close vessels, if the process be conducted with common precautions, there is no source of difficulty or danger, and it may easily be assisted by artificial cold, in cases where gases approach near to that point of compression and temperature at which they become vapors."

This "bent tube" method was successfully employed by Faraday in the liquefaction of a number of other gases.

In 1822, the year preceding Faraday's experiments on chlorine, Cagnier de la Tour had examined the effects produced by heating volatile liquids, such as alcohol or ether, in closed tubes. In these experiments the liquid put into the tube was sufficient to fill it half full, and the whole of the tube was heated, so that the conditions were different from those of Faraday's experiments. De la Tour observed that up to a certain temperature the liquid continued slowly to evaporate, the bulk of liquid diminishing, and the quantity of vapor increasing. This was the ordinary process of

evaporation, which the eye can trace by observing that the position of the meniscus which separates the liquid and the vapor becomes lower and lower as the temperature increases.

When, however, a certain temperature is reached the meniscus suddenly disappears, and there no longer appears to be any liquid in the tube. On cooling the tube, the inverse change takes place with equal suddenness, a meniscus (the line of separation between liquid and vapor) suddenly appears, showing that on lowering the temperature a large amount of liquid is suddenly formed. De la Tour's experiments point to conclusions quite opposite to those of Davy, quoted above; since the "approximation of particles" brought about by pressure was more than counterbalanced by the repellant action of heat.

In 1845, in a second paper on liquefaction of gases, Faraday writes with a mastery of the subject which neither he nor Davy possessed in 1826. He says (*Phil. Trans.*, 1845, p. 155): "My hopes of success beyond that heretofore obtained depending more upon depression of temperature than on the pressure which I could employ in these tubes, I endeavored to obtain a still greater degree of cold. There are, in fact, some results no pressure may be able to effect. Thus, solidification has not yet been conferred on a fluid (*i. e.*, a gas) by any degree of pressure. Again, that beautiful condition which Cagnier de la Tour made known, and which comes on with liquids at a certain heat, may have its point of temperature for some of the bodies to be experimented with, as oxygen, hydrogen, nitrogen, etc., below that belonging to the bath of carbonic acid and ether, and in that case no pressure which any apparatus could bear would be able to bring them into the liquid or the solid state." The "bath of carbonic acid and ether" here referred to, was a device for obtaining a very low temperature, a kind of improved freezing mixture in fact. Thilorier and afterward Natterer had constructed apparatus in which carbonic acid gas could be liquefied by pressure alone. When liquid carbonic acid is exposed to the air at the ordinary pressure, some of the liquid evaporates very rapidly, thereby chilling the lower layers of liquid to such an extent that they freeze, forming solid carbonic acid. If ether be mixed with this solid carbonic acid, and if the pressure be diminished by means of the air pump, the further cooling due to evaporation of the ether reduces the temperature to -110° C. This extremely low temperature was employed in experiments by which Faraday endeavored unsuccessfully to liquefy hydrogen, oxygen and nitrogen. Andrews employed the same means of producing cold, but used more powerful apparatus for compression. Although by combined cold and pressure the above named gases were reduced to less than $\frac{1}{100}$ of their original volume, no liquefaction took place. Andrews also conducted experiments upon the phenomenon observed by De la Tour, and showed that above the "critical temperature" of 31° C. the greatest pressure which he could bring to bear was not sufficient to liquefy carbonic acid, but that, if the temperature were lowered, the liquefaction took place at once.

In the latter and successful experiments on the liquefaction of the "permanent gases," such as nitrogen, oxygen, and hydrogen, the skill of the experimenter has been chiefly shown in the means devised for obtaining temperatures below the "critical point" of these gases. Pictet, of Geneva, who liquefied oxygen in 1877, relied for the production of a low temperature upon the well known principle of latent heat of evaporation. The novelty in his application of this principle lay in the fact that he employed two evaporating substances—namely, sulphur dioxide and carbonic acid. By the use of the doubly acting pumps employed in refrigerating machinery (*vide Knowledge*, March, 1891, "Artificial Cold") liquid sulphur dioxide can be obtained having a temperature of -65° C. In Pictet's apparatus the cold liquid sulphur dioxide is contained in an annular vessel, which forms a jacket round the tube in which carbonic acid is condensed by the action of another doubly acting pump.

The liquid carbonic acid is reduced to a temperature of 65° C. by the cooling action of the "jacket," and, consequently, when the pump is reversed and used as an exhaust pump, the evaporation of the cooled liquid produces an extremely low temperature, and the vapor can again be condensed so as to form a liquid jacket round the oxygen tube, having a temperature of -130° C. This tube of copper was made very strong to withstand pressure. The oxygen gas was passed into the tube direct from a strong iron retort in which it was evolved, and thus the pressure continued to rise as more and more oxygen entered the tube. At a pressure of about five hundred atmospheres, the manometer remained stationary, showing that liquefaction had begun. The whole of the tube was at length filled with liquid oxygen, which was examined by opening a stopcock, when a jet of a lustrous liquid issued with great force from the tube, to be speedily dissipated by evaporation.

Cailletet, who worked independently at the same problem, first succeeded in liquefying oxygen on the very same day as Pictet. He employed simpler appliances, and worked on a different principle. He relied for obtaining his frigorific effect upon the *chaleur de détente*, or latent heat of expansion, of the gas with which he was working. The term "latent heat of expansion" is not a very good one, as gas is not cooled by merely expanding to fill a vacuum. When, however, a gas is allowed to expand in such a way as to do mechanical work, the gas loses in heat the thermal equivalent of the mechanical work performed. In Cailletet's experiments, the gas was contained over mercury in the capillary bore of an immensely strong glass tube. The tube was screwed into an hydraulic press worked by the leverage of a large wheel. The experimental glass tube was surrounded by a freezing mixture of which the temperature for the experiments was not lower than about -30° C. So that in Cailletet's experiments no attempt was made to surround the gas with a very cold atmosphere. When the pressure attained three hundred atmospheres the oxygen still remained in the gaseous condition, being much above the critical temperature, but, on suddenly withdrawing the constraining force from the piston of the press, the gas suddenly expands, the elasticity or spring of the gas drives back the liquid and the piston, and the sudden mechanical effort of the gas is accompanied by a sudden chill sufficient to bring the tempe-

perature below the critical point. The liquefied oxygen was seen in the tube immediately the pressure was released. Cailletet's method had the advantage that the process could be watched through the glass walls of the tube. On the other hand, Pictet's arrangement enabled him to prepare a larger quantity of the material, and to observe its behavior when exposed freely to the atmosphere. As we have said, the liquefied oxygen was dissipated immediately by evaporation, so that no examination of its properties could be made. A finemist, or cloud, which formed when the oxygen evaporated may have been due to small particles of solid oxygen.

Experiments conducted since those of Cailletet and Pictet, fifteen years ago, have been designed so as to permit of the examination of the physical properties of the liquefied substances. This has been effected by obtaining such low temperatures of the material, and such a low temperature of its immediate surroundings, that the evaporation of the liquid (whether hydrogen, oxygen, or nitrogen) only takes place slowly under ordinary atmospheric pressure. In Cailletet's experiments, a liquid was obtained under low pressure, but the surroundings of the liquid were relatively warm, so that the substance could not long remain liquid. In Pictet's experiments the liquid could only be examined by removing it from the cold atmosphere. In the experiments conducted by Dr. K. Olszewski the gas to be experimented on was contained in the innermost of four glass tubes placed one within the other. In the outermost tube was placed solid carbonic acid and ether. By placing this in connection with an air pump, the temperature of the neighboring tubes was reduced to -100° C. This was the method for obtaining low temperatures employed by Faraday in his later researches. Now comes a novelty. Ethylene gas, brought from a Natterer's cylinder, is led into the (second) inner tube. Here it is liquefied by low temperature, and under a considerable pressure. The two innermost tubes (into which the oxygen or hydrogen are presently to be brought) are now surrounded by a tube containing liquid ethylene at about -100° C. This liquid is protected from the warmth of the air by the outermost jacketing tube of carbonic acid ice. By the action of an air pump the pressure on the liquid ethylene is reduced to 10 mm. of mercury (about $\frac{1}{10}$ the ordinary atmospheric pressure); dry air at the same time is cautiously blown through the ethylene to prevent its evaporation from becoming violent. The gas (say oxygen) is now passed into the two innermost tubes. The intense cold produced by the evaporation of the liquid ethylene, the liquid being to begin with at about -100° C., liquefies the oxygen, which is under a considerable pressure. But one more device remains to be mentioned, the most singular of all in Dr. Olszewski's process. The two innermost tubes, as has been said, contain the liquefied oxygen. They are now both put into connection with the air pump, and the pressure is cautiously diminished. The liquid in both tubes begins to evaporate, and is thereby chilled. Presently, the liquid in the outer tube begins to evaporate more quickly than that in the innermost one, owing to the fact that it is in contact with the (relatively) warm ethylene tube. The whole of the liquid in the outer tube consequently evaporates while there still remains a considerable portion of the liquid in the innermost tube. The temperature of the innermost tube has now sunk considerably lower than that of the liquid ethylene. Nitrogen can be frozen in this way. By diminishing the pressure on the solid nitrogen, and thereby causing evaporation, Olszewski obtained a temperature of -225° C., or less than 50° C. from the supposed absolute zero of temperature, that is to say, the point at which all the heat has been extracted from a body.

The exceedingly cold liquid contained in the innermost tube is protected from the relatively warm ethylene by the non-conducting layer of rarefied gas in the intermediate tube. Consequently, the substance remains liquid at atmospheric pressure, or even at lower pressure, for a space of time (five to fifteen minutes) sufficient to allow of an examination of some of the important physical properties. Thus the specific gravity is determined by measuring the height at which the liquid stands in the tube, hence deducing the volume of the liquid; then collecting the gas after evaporation, and measuring its volume. The weight of a given volume of gas is, of course, well known. This is necessarily equal to the weight of the liquid before evaporation. Hence we know the weight of the liquid in the tube. Its volume having been ascertained in the way described, the specific gravity is readily calculated under atmospheric pressure; it is found that—

	Melts at.	Boils at.	Critical Temp.
Oxygen...	—	-164°	-118.8° C.
			Sp. gr. of liquid, 1.124 at -181.4° C.
Nitrogen....	-214°	-194.4°	-146° C.
			Sp. gr. of liquid, 0.885 at -194° C.

Hydrogen at -213° C. liquefied under a pressure of 190 atmospheres; with Pictet's temperature of 140° C. a pressure of 650 atmospheres was required. The temperatures recorded in the above observations were all registered with a hydrogen thermometer. The critical point of hydrogen is -220° C.—*Knowledge*.

THE PREPARATION AND ESTIMATION OF PURE PLATINUM.

By Herren F. MYLIUS and F. FORSTER.

THE authors, having recounted the known methods devised by Deville and Stas for the analysis and purification of the metals of the platinum group, and having substantiated the accuracy of the separations of the metals on which they depend, comment on certain disadvantages that these processes possess. They have devised a method by which the platinum may be volatilized from other metals present in small quantity, and with this object in view they have investigated the volatility of such metals as are likely to be present, as well as that of platinum itself when heated in a current of chlorine mixed with carbon monoxide. The formation of volatile compounds of platinum under these conditions has been lately investigated anew by Pullinger, and by the authors themselves, and its appli-

cability was tried by them in the following manner: Five to ten grammes of platinum, preferably in the form of "sponge," contained in a porcelain boat, was heated in a thin-walled tube drawn out to a long neck at one end and attached to an apparatus for generating chlorine and to a gasholder filled with a mixture of carbon monoxide and carbon dioxide produced by the action of sulphuric acid upon oxalic acid. The further end was closed by a cork, and carried a tube dipping into caustic soda to absorb objectionable fumes. The part of the tube containing the boat was heated to about 238° C.

At first chlorine alone was passed over the metal under treatment, and afterward a mixture of chlorine and carbon monoxide. Excess of the former was found to be inadvisable, as dark-colored sparingly volatile products were formed, which, however, were easily sublimed by subsequent treatment with carbon monoxide. Ten grammes of platinum could be volatilized in this way in six or eight hours. The process was found to be unsuited for the analysis of platinum alloys, as the presence of about one per cent. of iridium caused the distillation to proceed very slowly, and considerable quantities of platinum remained in the residue. With sensibly pure platinum, however, no such difficulty occurs, and even thin sheet can be used. The platinum can be easily recovered from the sublimed compounds with chlorine and carbon monoxide by solution in strong hydrochloric acid and decomposition of this solution by the addition of water. The determination of the platinum by this method is not to be recommended, but it may be indirectly estimated by the loss in weight of the contents of the boat.

The behavior of the metals likely to be present in platinum of commercial purity was then ascertained. Iridium gave a sublimate strongly resembling that yielded by platinum, and separation of a trace of iridium from a large quantity of platinum could not be effected. Palladium alone gave no sublimate, but volatilized in the presence of an excess of platinum, only a trace being left in the non-volatile residue. Rhodium was not appreciably volatile; 1 mgrm. could be recognized in 10 grammes of platinum. Ruthenium, osmium, and gold were all volatile. Silver, copper, lead, and zinc were non-volatile, while iron easily sublimed. The method was therefore shown to be available for the metals rhodium, silver, copper, lead, and zinc.

The process can be used to supplement the Deville-Stas method in the following way: The aqua regia solution of platinum containing rhodium and lead obtained in the course of the standard method is freed as far as possible from excess of acid, neutralized with ammonia, excess of formic acid added together with some ammonium acetate, made up of 500 c. c., heated on the water bath to 70°-80° C. until the carbon dioxide which is freely evolved at the beginning slackens somewhat, and then boiled in conjunction with a vertical condenser for 24-30 hours. The precipitated metal is washed with dilute hydrochloric acid and dried over sulphuric acid and caustic potash. The dried metal is heated cautiously in hydrogen, weighed, and treated by the carbon monoxide and chlorine process already in outline described. The non-volatile residue is extracted with nitric acid to remove the lead, while the rhodium is separated from the small quantity of platinum remaining in the boat, by fusion with bisulphate of potash.

Small amounts of impurities in platinum are therefore best determined by the following method: Three distinct portions are taken; the first is tested for palladium, iridium, and ruthenium by the ordinary lead method of Deville and Stas; a second portion is dissolved in aqua regia and the filtrate examined for iron after the reduction of the platinum by means of formic acid; the third is volatilized by the new carbon monoxide and chlorine method, and rhodium, silver, copper, and lead looked for in the residue. The following quantities can be detected if 10 grammes of platinum be used for each operation: Iridium, 0.008; ruthenium, 0.005; rhodium, 0.004; palladium, 0.01; iron, 0.001; copper, 0.002; silver, 0.002; lead, 0.002 per cent. respectively.

Preparation of Pure Platinum.—Commercial platinum is not even approximately pure. Appended are two analyses, the first of a platinum crucible, the second of a sample of "purified" platinum:

	Platinum crucible.	"Purified" platinum.
	Per cent.	Per cent.
Platinum.....	96.90	99.28
Iridium.....	2.56	0.32
Rhodium.....	0.20	0.13
Palladium.....	trace	
Ruthenium.....	0.02	0.04
Iron.....	0.20	0.06
Copper.....		0.07
	*99.88	99.90

*99.58 in original.

The need for pure platinum for the preparation of standard weights and measures made from a platinum-iridium alloy of known composition was the first cause that led to a serious attempt being made to purify platinum beyond the limits here indicated, and success in this direction has been achieved by the well-known firm of Johnson, Mathey & Co., who use the lead process of Deville and Stas. The authors have detected in the purest samples from this firm 0.01 per cent. of rhodium and 0.01 per cent. of silver, both impurities being among the list of those for the detection of which the carbon monoxide and chlorine method is especially suitable.

Lately Herr W. O. Heräus has engaged in the production of pure platinum, which is stated to be preferable to the English material, as no lead is used in the process of purification. A sample examined by the authors contained only a trace of iridium, not quantitatively determinable, and no detectable amount of palladium or rhodium. The amount of iron present did not exceed 0.001 per cent. Finkener's method for purifying platinum was adopted. It consists essentially in the conversion of the platinum into the double sodium chloride salt and the recrystallization of this salt from a solution made alkaline with soda. The solution of platonic chloride, freed from oxides of nitro-

gen, was evaporated with the calculated amount of sodium chloride (free from iron) to dryness, and well stirred while cooling. The mother liquor was removed from the crystals, and the latter were washed with a strong solution of sodium chloride and dissolved in a 1 per cent. soda solution. A very small quantity of a dark precipitate containing iridium remained.

The salt separated by the cooling of the filtered solution was repeatedly recrystallized from slightly alkaline solution without the formation of any similar precipitate. The purified salt thus obtained was dehydrated at 120° C., and reduced in hydrogen at a low temperature, the resulting platinum sponge washed repeatedly with water, dried, and ignited, the ignited metal being also washed with dilute hydrochloric acid, dilute hydrofluoric acid, and again with water.

With regard to the purity of the platinum thus prepared, it appeared probable that the maximum limit for the total quantity of foreign matter was 0.01 per cent., that is to say, there was present 99.99 per cent. of platinum. The conclusion arrived at by this investigation is that platinum is a metal which can be brought to a high state of purity with ease and certainty.—*Ber.*, 25, 1892, 665-686, through *Jour. Soc. Chem. Ind.*

THE SCIENTIFIC AMERICAN Architects and Builders Edition \$2.50 a Year. Single Copies, 25 cts.

This is a Special Edition of the SCIENTIFIC AMERICAN, issued monthly—on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid Magazine of Architecture, richly adorned with elegant plates in colors and with fine engravings, illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction.

Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost endless series of the latest and best examples from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of Grounds, etc., are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described and illustrated, with addresses of the makers, etc.

The fullness, richness, cheapness, and convenience of this work have won for it the Largest Circulation of any Architectural publication in the world.

A Catalogue of valuable books on Architecture, Building, Carpentry, Masonry, Heating, Warming, Lighting, Ventilating, and all branches of industry pertaining to the art of Building, is supplied free of charge, sent to any address.

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

THE SCIENTIFIC AMERICAN Cyclopedia of Receipts, NOTES AND QUERIES.

680 PAGES. PRICE \$5.

This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during nearly half a century past; together with many valuable and important additions.

Over Twelve Thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulae used in the various manufacturing industries, will here be found answered.

Instructions for working many different processes in the arts are given. How to make and prepare many different articles and goods are set forth.

Those who are engaged in any branch of industry probably will find in this book much that is of practical value in their respective callings.

Those who are in search of independent business or employment, relating to the manufacture and sale of useful articles, will find in it hundreds of most excellent suggestions.

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

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,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

	PAGE
I. BIOGRAPHY.—John Greenleaf Whittier.—A biography of the Quaker poet from an English standpoint, with portrait.—3 illustrations.....	14026
II. CHEMISTRY.—The Preparation and Estimation of Pure Platinum.—By Herren F. MYLIUS and F. FORSTER.—Applicability of the formation of a volatile platinum compound for the production of the chemically pure metal. With analyses and details.....	14037
III. CYCLING.—What Keeps the Bicycle Upright?—Popular exposition of the philosophy of the bicycle.—3 illustrations.....	14025
IV. DRAWING.—The Rendu of Architectural Drawings.—A thoroughly practical article on the introduction of shades and shadows in right line pen drawing.—4 illustrations.....	14025
V. ELECTRICITY.—An Electrical Cigar Lighter.—A cigar lighter operating by an incandescent platinum wire.—1 illustration.....	14032
Electro-Metallurgy.—A most interesting lecture on modern electroplating and analogous processes, giving the result of the most recent achievements in that direction, including the production of aluminum.....	14032
The Siemens & Halske Dynamos.—Large dynamos.—The increasing tendency of the day toward the employment of large units in commercial generators.—Examples of German practice in this direction.—2 illustrations.....	14032
VI. ENTOMOLOGY.—Observations on the Habits of a Mason Wasp.—Interesting and graphic account of the habits of this insect. How it catches its prey for the maintenance of its young.—5 illustrations.....	14035
VII. MEDICINE AND HYGIENE.—The Treatment of Typhoid Fever.—A traversment of some of Sir Wm. Gull's views as to the treatment of typhoid fever by a practitioner of twenty-one years' experience.....	14036
VIII. METALLURGY.—Ternary Alloys.—By Mr. C. R. ALDER WRIGHT.—Aluminum alloys containing two metals besides aluminum.—The constants of the alloys and general properties.....	14034
IX. NAVAL ENGINEERING.—The New Cunard Steamer Campania.—The largest ship in existence, recently launched at the Govan Ship Yards.—Only slightly inferior in dimensions to the Great Eastern.—1 illustration.....	14024
The Sand Pump Hopper Dredger Thyboron.—A dredge recently built for the Danish government for the removal of sand bars by pumping.....	14024
United States Cruiser No. 12.—The Columbia.—The largest ship in the navy of the United States, popularly termed the Pirate.—1 illustration.....	14023
X. PHOTOGRAPHY.—The First Application of Bromine.—An interesting point in the history of photography.—The early use of the great accelerator.....	14027
XI. PHYSICS.—Color.—By President HENRY MORTON.—A recent lecture on the physiology and physics of color, delivered under the auspices of the Carriage Builders' National Association.—13 illustrations.....	14030
The Liquefaction of Gases.—By VAUGHAN CORNISH.—Early history of the attempts at the liquefaction of gases and some of the most recent results obtained by scientists.....	14037
XII. TECHNOLOGY.—History of Artificial Illumination.—Consideration of this most exhaustive treatise, giving the mathematics of the subject as well as treating it from an engineering standpoint.—A review of the different kinds of modern gas burners and classification of stoves.....	14027
XIII. ZOOLOGY.—The Wild Boar and his Ways.—By Dr. G. ARCHIE SPENCER.—An exceedingly interesting account of the wild boar.—How it is hunted.—Its ferocity.—Its habits in different countries.....	14035

A New Catalogue of Valuable Papers

Contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent free of charge to any address. MUNN & CO., 361 Broadway, New York.

Useful Engineering Books

Manufacturers, Agriculturists, Chemists, Engineers, Mechanics, Builders, men of leisure, and professional men, of all classes, need good books in the line of their respective callings. Our post office department permits the transmission of books through the mails at very small cost. A comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had forty-five years' experience, and now have unequalled facilities for the preparation of Patent Drawings, Specifications, and the prosecution of applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Copyrights for Books, Labels, Reissues, Assignments, and Refutations of Infringements of Patents. All business entrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, containing full information about Patents and how to secure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Infringements, Assignments, Rejected Cases, and on the Sale of Patents, etc.

We also send, free of charge, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—Nos. 622 and 624 F Street, Pacific Building near 7th Street, Washington, D. C.