

Scientific American Supplement, No. 832, December 12, 1891 eBook

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Page 1

THE GREAT BELL OF THE BASILICA OF THE SACRED HEART OF MONTMARTRE.

The main work on the basilica of the Sacred Heart is now completed and the bell tower surmounts it. So we have now a few words to say about “La Savoyarde”—the name of the great bell which is designed for it, and which has just been cast at Annecy-le-Vieux, in Upper Savoy, in the presence of Mgr. Leuilleux, Archbishop of Chambéry, Mgr. Isoar, Bishop of Annecy, and of all the clergy united, at the foundry of Messrs. G. & F. Paccard, especially decorated for the occasion.

[Illustration: *Interior of the bell.*]

One of the Latin inscriptions that ornament the metal of “La Savoyarde” at once explains to us its name and tells us why a bell designed for the capital was cast at Annecy-le-Vieux. The following is a translation of it:

“In the year 1888, in the course of the solemnities of the sacerdotal jubilee of the Sovereign Pontifex Leo XIII., I, Frances Margaret of the Sacred Heart of Jesus, on the initiative of Francis Albert Leuilleux, Archbishop of Chambéry, with the co-operation of the bishops of the province, at the common expense of the clergy and upper and lower classes of Savoy, was offered as a gift, as a testimonial of piety toward the divine heart, in order to repeat through the ages, from the top of the holy hill, to the city, to the nation and to the entire world, ‘Hail Jesus!’”

Let us now witness the casting of the bell.

Over there, at the back of the foundry, in the reverberatory furnace, the alloy of copper and tin, in the proportions of 78 and 22 per cent., is in fusion. From the huge crucible runs a conduit to the pit, at the side of which the furnace is constructed, and in which is placed the mould. A metallic plug intercepts communication. A quick blow with an iron rod removes this plug and the tapping is effected. This operation, which seems simple at first sight, is extremely delicate in practice and requires a very skillful workman. A host of technical words designates the dangers that it presents. Before the tapping, it is necessary to calculate at a glance the function of the gate pit. And what accidents afterward! But we need not dwell upon these. After the cooling of the metal comes the cleaning, which is done with scrapers and special instruments.

The casting is preceded by two operations—the designing and the moulding. The design rests upon a basis generally furnished by experience, and which the founders have transmitted from generation to generation. The thickness of the rim of the bell taken as unity determines the diameters and dimensions. The outline most usually followed gives 15 rims to the large diameter, 7 1/2 to the upper part of the bell, and 32 to the large radius that serves to trace the profiles of the external sides.

[Illustration: *The casting of the great bell of the basilica of the sacred heart.*]

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The moulding is done as follows: In the pit where the casting is to be done there is constructed a core of bricks and a clay shell, separated from each other by a thickness of earth, called false bell. This occupies provisionally the place of the metal, and will be destroyed at the moment of the casting.

Now let us give a brief description of “La Savoyarde.” Its total weight is 25,000 kilogrammes, divided as follows: 16,500 kilogrammes of bronze, 800 kilogrammes for the clapper, and the rest for the suspension gear.

Its height is 3.06 meters and its width at the base is 3.03. It is therefore as high as it is wide, and, as may be seen from our engraving, two men can easily seat themselves in its interior. In weight, it exceeds the bell of Notre Dame, of Paris, which weighs 17,170 kilogrammes, that of the Cathedral of Sens, which weighs 16,230, and that of the Amiens bell, which weighs 11,000. But it cannot be compared to the famous bell given by Eudes Rigaut, Archbishop of Rouen, to the cathedral of that city, and which was so big and heavy that it was necessary to give a copious supply of stimulants to those who rang it, in order “to encourage” them.

[Illustration: *The great bell of the basilica of the sacred heart.*]

“La Savoyarde” will appear small also if we compare it with some celebrated bells, that of the Kremlin of Moscow, for example, which weighs 201,216 kilogrammes. One detail in conclusion: “La Savoyarde” sounds in counter C. This had been desired and foreseen. The number of vibrations, that is to say, the *timbre* of a bell, is in inverse ratio of its diameter or of the cubic root of its weight, so that in calculating the diameters and in designing “La Savoyarde” the *timbre* was calculated at the same time.—*L’Illustration*.

* * * * *

[*From the sugar beet.*]

NEW SUGAR ITEMS.

France.

Water that has been used to wash frozen beets contains a small percentage of sugar. As the washing period, in such cases, is longer than with normal beets, the sugar in beet cells has time to pass through the outer walls by osmosis. The sugar loss is said to be 0.66 per cent. (?) of the weight of beets washed.

Well conducted experiments show that in small but well ventilated silos, beets lose considerable weight, but very little sugar. On the other hand, in large silos with poor ventilation, the sugar loss frequently represents four to six per cent. When fermentation commences, the mass of roots is almost ruined.



Sodic nitrate, if used upon soil late in the season, may overcome a difficulty that has been recently noticed. Beet fields located near swamps that are dry a portion of the year have suffered from a malady that turns leaves from green to yellow, even before harvesting period; such beets have lost a considerable amount of sugar.

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A new method for the analysis of saccharose and raffinose, when in the presence of inverted sugar, is said to give accurate results. The process consists in adding sulphate of copper and lime to hot molasses, so that the oxide of copper is changed to a protoxide, and the invert sugar becomes water and carbonic acid. The whole is neutralized with phosphoric acid. There follow a great number of precipitates; the exact volume of liquid in which these are found is determined after two polariscopic observations.

It has been constantly noticed that samples of carbonatated juice vary in composition with the part of tank from which they are taken. If some arrangement could be made assuring a thorough mixing during the passage of carbonic acid, results would be more satisfactory than they now are. If gas could be distributed in every part of the tank, the lime combination could be made perfect.

Notwithstanding the new law regulating quantity of sugar to be used in wines, ciders, *etc.*, there has been, during 1890, an increase of nearly 13,000 tons, as compared with 1889. Consumption of sugar for these special industries was 33,000 tons; alcohol thus added to wine was about 71,000,000 gallons.

Beets cultivated without extra fertilizers, and that are regular in shape and in good condition, without bruises, are the ones which give the best results in silos. It is recommended to construct silos of two types; one which is to be opened before first frost, the other where beets remain for several months and are protected against excessive cold. Great care should be taken that a thorough ventilation be given in the first mentioned type. In the other, more substantial silos, ventilation must be watched, and all communication with the exterior closed as soon as the temperature falls to or near freezing.

During the last campaign many manufacturers experienced great difficulty in keeping the blades of slicers sufficiently sharp to work frozen beets. Sharpening of blades is an operation attended to by special hands at the factory; and under ordinary circumstances there need be no difficulty. However, it is now proposed to have central stations that will make a specialty of blade sharpening. Under these circumstances manufacturers located in certain districts need give the matter no further thought, let the coming winter be as severe as it may.

Some success has been obtained by the use of sulphurous acid in vacuum pans. Great care is required; the operation cannot be done by an ordinary workman. It is claimed that graining thereby is more rapid and better than is now possible. Chemists agree that the operation is more effectual by bringing sulphurous acid in contact with sirups rather than juices; it is in the sirups that the coloring pigments are found. Sulphurous acid is run into the pan until the sirups cover the second coil. In all cases the work must be done at a low temperature.

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Height of juice in carbonatating tanks is only three feet in France, while in Austria it is frequently twelve feet. The question of a change in existing methods is being discussed; it necessitates an increase in the blowing capacity of machine; since carbonic acid gas has a greater resistance to overcome in Austrian than in French methods. Longer the period juices are in contact with carbonic acid, greater will be the effect produced.

Ferric sulphate has been very little used for refuse water purification, owing to cost of its manufacture. If roasted pyrites, a waste product of certain chemical factories, are sprinkled with sulphuric acid of 66 deg. B., and thoroughly mixed for several hours, at a temperature of 100 deg. to 156 deg. F., the pyrites will soon be covered with a white substance which is ferric sulphate. Precipitates from ferric sulphate, unlike calcic compounds, do not subsequently enter into putrefaction.

Efforts are being made to convince manufacturers of the mistake in using decanting vats, in connection with first and second carbonatation. In Germany filter presses are used, decanting vats are obsolete. The main objection to them is cooling of saccharine liquors, which means an ultimate increase in fuel. Cooling is frequently followed by partial fermentation.

Further changes in the proposed combined baryta-soda method for juice purification consist in using powdered soda carbonate 90-92 deg., upon beet cossettes as they leave the slicer, before entering the diffusor. The quantity of chemical to be used is 1/1000 of weight of beet slices being treated. If a diffusor has a capacity of 2,500 lb., there would be added 2.5 lb. soda carbonate. From the diffusor is subsequently taken 316 gallons juice at 4-5 deg. density, this is rapidly heated to 185 deg.F., then 2.4 of a pure baryta solution is added; temperature is kept at 185 deg. F. for a short time; resulting precipitates fall to bottom of tank; then 13 gallons milk of lime 25 deg. B. are added.

Other operations that follow are as usual. It is contended that the cost of baryta is 10 cents per ton beets worked. The most important advantage is gain in time; a factory working 20,000 during a 100-day campaign, by the foregoing process can accomplish the same work in 80 days, thus decreasing wear and tear of plant and diminishing percentage of sugar lost in badly constructed silos.

The exact influence of a low temperature upon beet cells has never been satisfactorily settled. Considerable light has recently been thrown upon the subject by a well known chemist. It is asserted that living cells containing a saccharine liquid do not permit infiltration from interior to exterior; this phenomenon occurs only when cell and tissue are dead. It is necessary that the degree of cold should be sufficiently intense, or that a thaw take place, under certain conditions, to kill tissue of walls of said cells. An interesting fact is that when cells are broken through the action of freezing, it is not

those containing sugar that are the first affected. The outer cells containing very little sugar are the first to expand when frozen, which expansion opens the central cells.

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Experiments to determine the action of lime upon soils apparently prove that it does not matter in what form calcic salts are employed; their effect, in all cases, is to increase the yield of roots to the acre. On the other hand, very secondary results were obtained with phosphoric and sulphuric acids.

A micro-mushroom, a parasite that kills a white worm, enemy of the beet, has been artificially cultivated. As soon as the worm is attacked, the ravage continues until the entire body of the insect is one mass of micro-organisms. Spores during this period are constantly formed. If it were possible to spread this disease in districts infected by the white worm, great service could be rendered to beet cultivation.

In sugar refining it is frequently desirable to determine the viscosity of sirups, molasses, *etc.* Methods founded upon the rapidity of flow through an orifice of a known size are not mathematical in their results. A very simple plan, more accurate than any hitherto thought of, is attracting some attention. Sensitive scales and a thermometer suspended in a glass tube are all the apparatus necessary. The exact weight of thermometer, with tube, is determined; they are immersed in water and weighed for the second time; the difference in weight before and afterward gives the weight of adhering water. If the operation is repeated in molasses, we in the same way obtain the weight of adhering liquid, which, if divided by the weight of adhering water, gives the viscosity as compared with water.

Sugar refineries located at Marseilles claim that it is cheaper for them to purchase sugar in Java than beet sugar of northern Europe. On the other hand, the argument of Paris refiners is just the reverse. The total refined sugar consumed is 375,000 tons, the colonial and indigenous production of raw sugar is nearly 1,000,000 tons more than sufficient to meet the demands of the entire refining industry of the country. There appears to have been considerable manipulation, foreign sugar being imported with the view of producing a panic, followed by a decline of market prices, after which Marseilles refiners would buy. All sound arguments are in favor of protecting the home sugar industry.

It has been suggested that manufacturers weigh the fuel used more carefully than hitherto; the extra trouble would soon lead to economy for all interested in sugar production at ruinous cost. Some chemists advocate that coal be purchased only after having been analyzed. Efforts to have a unification in methods of analysis of all products of factory is a move in the right direction; the Association of Sugar Chemists have adopted a series of methods that are in the future to be considered as standard.

Copper solutions are destined to render great service in the destruction of micro-organisms that attack the beet field. The liquid used should be composed of 3 per cent. copper sulphate and 3 per cent. lime, dissolved in water; fifty gallons are sufficient for one acre; cost per acre, every item included, is 56 cents. The normal vitality of the plant being restored, there follows an increased sugar percentage. Ordinary liquid ammonia

may be advantageously used to kill white worms and insects that attack beets; two quarts of the diluted chemical are used per square yard, and the cost is \$12 per acre (?)

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GERMANY.

Calcic salt elimination from beet juices is a problem not yet satisfactorily solved. Since the early history of beet sugar making, it has been noticed that calcic salts render graining in the pan most tedious; hence repeated efforts to reduce to a minimum percentage the use of lime during defecation. In all cases it is essential to get rid of inverted sugar. The difficulty from excess of lime is overcome by adding it now and then during carbonatation; but other means are found desirable; and phosphoric acid, magnesia, soda, *etc.*, have been used with success. Recent observations relating to the action of soda upon calcic sulphates, calcic glucates, *etc.*, are most important. Certain citrates have a retarding influence upon calcic sulphates.

An alarm contrivance to announce the passage of juices into condensing pipes has rendered considerable service in beet sugar factories.

A process for refining sugar in the factory, at less cost than it is possible to make raw sugar by existing processes, deserves notice. Sugars by this new method test 99.8, and sirups from the same have a purity coefficient of 70. Weight of dry crystals obtained is said to represent 66 per cent. of *masse cuite* used. The additional cost of the process is \$30 to \$40 per centrifugal. Concentrated juice or sirup may be used as *cleare* in centrifugals; this sirup should have a density of 1.325 (36 deg. B.) at 113 deg. to 122 deg. F., so as not to redissolve the sugar. Sirup should not be used until all adhering sirup of *masse cuite* has been swung out. The sirup, after passing through centrifugals, may be sent to second carbonatation tanks and mixed with juices being treated.

The larva of an insect, known as *sylpha*, has attacked beet fields in several parts of Saxony. The effect upon the root is a decrease in foliage, followed by late development of the beet, with corresponding reduction in sugar percentage. Chickens may render excellent service, as they eat these worms with considerable relish. A solution of Schweinfurt green has been used with some success; its cost is \$2.50 per acre. None of the chemical remains on the leaves after a rain (?) White worms have done some damage; they should be collected from the fields during plowing. When they become beetles in the spring, they may be destroyed by a solution of sulphide of carbon; \$0.20 worth of this chemical is sufficient to kill 10,000 of them. These beetles contain 50 per cent of fatty and nitric elements; when pulverized they may be used as good for pigs and chickens. If the ground mass of beetles is sprinkled with sulphuric acid and a reasonable amount of lime and earth be added, the combination forms an excellent fertilizer for certain crops. A disease that blackens young beet leaves is found to be due to a microscopic insect. If the beet seed be saturated in a phenic solution before planting, the difficulty may be overcome.

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We are soon to have a new method for selecting mothers for seed production. Details of the same are not yet public. It is claimed that it will be possible to grow seed that will yield beets of a given quality determined in advance, a problem which has hitherto been thought impossible.

It will surprise many of our readers to learn that if "tops" or even half beets are planted, they will give seed, the quality of which is about same; showing that as soon as seed stalks commence to appear, the *role* of the root proper is of secondary consideration, as it serves simply as a medium between the beet and soil(?)

Sprayed water may be used with considerable success in washing sugar in centrifugals; it is claimed that this new process offers many advantages over either steam, water, or use of *cleare*. White sugar to be washed is thoroughly mixed with a sugar sirup supersaturated. The whole is run into centrifugals. The sirup swung from the same is used in next and following operations; when it becomes too thick it is sent to the vacuum pan to be regrained. The operation of washing lasts less than two minutes; three quarts of water are necessary for 200 lb. sugar. The water spray at a pressure of 5 to 10 atmospheres is produced by a very simple appliance.

Total weight of refuse cossettes obtained during last campaign was 4,000,000 tons, about 700,000 tons of which were sold for \$1,000,000; if what remains is dried, it would be worth \$5,000,000.

Several sodic-baryta methods have been recently invented. Of these we will mention one where $1/4000$ to $1/2000$ part of calcined soda is added to the beet slices in diffusors. The juice when drawn from the battery is heated to 154 deg. F., and defecated with hydrate of baryta and milk of lime. Nearly all foreign substances are thus eliminated. Carbonatation then follows.

Government taxation upon the sugar industry is destined within a few years to be withdrawn. The new law recently put into operation no longer taxes beets worked at factory, but the sugar manufactured. The rate of taxation is about 2 cents per pound on all sugar made.

Recent data from northeast Germany give the work during campaign 1890-91 of 54 associated beet sugar factories. They used 2,130,000 tons beets, obtained from 142,602 acres of land, average yield 12 tons. The total sugar amounted to 251,000 tons, of which 241,000 were from beets and 10,000 tons from molasses worked by special processes. The polarization of beet juices averaged 13.09; *masse cuite*, 14.31; extraction of sugar of all grades, 11.79. It required 848 lb. beets to produce 100 lb. sugar.

In every center where beet sugar is made there exists some local society; each year members from these societies meet to exchange views upon the sugar situation of the empire.

Of late, there has been a general complaint respecting quality of sugar sold on the Magdeburg market. At one time the sugars averaged more organic substances than ash; now there is more ash than organic substances. Such sugars are most difficult to work, and cause much loss of time in centrifugals.

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The most desirable temperature for diffusion batteries is not yet definitely settled. Some manufacturers recommend 82 deg. to 86 deg. F. On the other hand, satisfactory results have been obtained at 145 deg. F., followed by cold water in the diffusors.

The use of hydrofluoric acid, even in small quantities to prevent fermentation, should not be allowed.

It is proposed to use hydrogen dioxide for saccharine juice purification. The alkalinity of juice is reduced to 0.07 by a judicious use of lime. Precaution must be taken to keep the temperature at 87 deg. F. After a preliminary filtration about 4 per cent. hydrogen dioxide is added. The whole is then heated to the boiling point, after which 1/2 to 1 per cent. lime is added. When alkalinity of filtrate is 0.03 phosphoric acid and magnesia are added, in quantities representing 0.03 per cent. of sugar in juice for magnesia, and 0.6 per cent. for the phosphoric acid. In working beet juices hydrogen dioxide may be used in the diffusor or during any phase of the sugar manufacturing process, even upon sugars in centrifugals. In all cases the results obtained are said to be most satisfactory.

A method to crystallize the sugar contained in the mother liquor of a *masse cuite* consists in mixing during 24 hours the hot product, direct from the pan, with low grade molasses. Gradual cooling follows. The crystals of *masse cuite* effect a crystallization of the otherwise inactive product contained in the molasses. The separation of crystals from adhering molasses is done in a special washing appliance arranged in battery form.

It has been frequently asked if the existing and accepted formula for determining in advance the amount of refined sugar that may be extracted from either beets, *masse cuite* or raw sugar, is to be considered exact, without special allowance being made for raffinose. An intelligent discussion upon the subject shows that the sugar in question, whether present or not, in no way influences the formula under consideration.

AUSTRIA-HUNGARY.

The committee on exhibition at Prague has issued several interesting pamphlets, from which we learn that in Bohemia, in 1819, there existed one beet sugar factory. In 1890 the total number of factories was 140; last year 370,000 acres were planted in beets, and the yield was 3,700,000 tons; yield of sugar averaged 2,700 lb. per acre; 40,000 hands were employed. During the past 24 years 17,900,000 tons of coal have been consumed, and the working capacity per factory is now far greater than formerly. There are at present seven sugar refineries in Bohemia.

Commercial arrangements with Germany having terminated favorably, great pressure is being brought to bear upon Italy, Roumania, Servia and Switzerland, to induce them to

enter into a treaty. Sugars imported by the country last named were 35,892 tons in 1889 and 43,300 tons during 1890.

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BELGIUM.

If fresh cossettes are fed to cows, in quantities per diem representing 20 per cent. of the animal's weight, they have a thinning effect. When the refuse has been siloed for eight months, and 12 per cent. of the animal's weight is used, there will follow a slight daily increase in weight. Better results may be obtained from cossettes that have been kept for two years; with the latter, if cows eat only 7 per cent. of their weight, considerable fattening follows. Consequently, while beet refuse, after long keeping, loses 50 per cent. of its weight, it appears in the end to be more economical for feeding purposes than fresh cossettes direct from the battery.

During this period of keeping the percentage of water remains nearly constant; fatty substances which were 0.08 per cent. become 0.74; and the percentage of carbohydrates diminishes. Chemists are unable to explain the changes that have taken place; if they are desirable, as they appear to be, judging from the practical results just cited, there is this question to be solved: What future have dried cossettes? Evidently they offer advantages, as no one can doubt, such as a decrease in weight and bulk, easy keeping for an indefinite time, *etc.* At present, there is building a silo to contain 4,000 tons fresh cossettes; this is to have the best possible system of drainage. During the coming season it is proposed to analyze the water draining from this mass of fermenting refuse; and we may then learn more than we now know about the chemical changes above mentioned.

A correspondent of M. Sachs asks why it is not possible to use live steam in defecating tanks. A simple calculation shows that the water to be subsequently evaporated would be increased 10 per cent. This evaporation would cost more than cleaning of copper coils, *etc.*, combined with other difficulties existing appliances offer.

The question as to the most desirable number of beets necessary to analyze to obtain an average has been in part settled. Factories working 500 tons per diem should make at least 200 analyses of beets received, which work offers no difficulty by the rapid methods now used. Several samples should be taken from every cart load delivered, then make average selections from the same.

RUSSIA.

Weak currents of electricity, 0.03 to 0.04 ampere, have been passed through sirups for fourteen hours without any special increase in purity coefficient. Experiments made upon diluted molasses or with raw beet juices were not encouraging.

Mixing of filter press scums with diffusion juices is said to offer special advantages for the preliminary purification. Not over one to two per cent. of scums should be used. If in too great quantity, the raw juices will yield inferior results. During operations that

follow, experiments are not yet sufficiently advanced to determine with certainty within what limits the refuse scum utilization process is to be recommended. We have great doubts as to the wisdom of introducing foreign elements, eliminated from other juices in a previous operation, into a juice fresh from the battery.

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OTHER COUNTRIES.

The beet sugar factory in Japan is said to be working with considerable success.

This year in Europe over 3,000,000 acres are devoted to beet cultivation. If the yield averages 12 tons, the crop of roots to be worked during campaign 1891-92 will certainly not be less than 36,000,000 tons, with a total yield of first grade sugar of about 7,300,000,000 lb.

Sugar sells for 9 cents per pound in Persia, where Russia has almost a monopoly of that business.

Finland imported, during 1889, 9,416 tons sugar, valued at \$1,000,000. Germany supplied two-thirds of this at cheaper rates than Russia, owing to facilities of transportation. Two refineries are working; one of these uses exclusively cane sugar, while the other employs both cane and beet sugar.

A beet sugar factory in England, that has been idle for many years, is to resume operations under a new company, adopting the plan of growing a sufficient quantity of beets for an average campaign, independently of what all the farmers of the locality propose to do.

Siberia is to have a beet sugar factory. Experiments in beet cultivation have shown excellent beets may be raised there. Special advantages are offered by the Russian government, and factories are to be exempt from taxation during a period of ten years. Sugar in Siberia is now considered an article of luxury, owing to distance and difficulties of transportation from manufacturing centers.

A special delegation from Canada has been sent to Europe, to study and subsequently report upon the true condition of the beet sugar industry.

A correspondent writes from Farnham, Canada, that the Canadian government grants a bounty of 2 cents per pound on beet sugar during campaign 1891-92. Duties on raw sugar were abolished last June.

* * * * *

AMERICAN WORKSHOPS.

An interesting paper on some of the leading American workshops was lately read before the members of the Manchester Association of Engineers on Saturday by Mr. Hans Renold. After expressing his opinion that the English people did not sufficiently look about them or try to understand what other nations were doing, Mr. Renold stated that

he had visited that portion of America known as New England, and the works he had inspected were among the best in the United States. Among the many special features he had noticed he mentioned that in a Boston establishment where milling machine cutters were made he had found that L1 spent in wages produced as much as L30 to L40 worth of goods, the cutters being made at the rate of about sixty-four per hour by about a dozen men. Another noticeable feature was the exceptional care taken in storing tools in American workshops. These, in fact, were treated as if they were worth their weight in gold; they were stored in safes much

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in the same manner as we in England stored our money. He was, however, impressed by the fact that the mere understanding of the method of American working would not enable them to do likewise in England, because the American workmen had gone through a special training, and a similar training would be necessary to enable English workmen to adapt themselves to American machines. One very noticeable feature in American engineering shops which he visited was that all the machine men and turners were seated on blocks or stools at their machines, and the question naturally arose in his mind what would English engineers say if such a practice were adopted in their shops. In other ways he was also struck by the special attention devoted to the comfort of the workmen, and he was much impressed by the healthy condition of the emery polishing shops as compared with similar shops in this country. In England these shops in most cases were simply deathtraps to the workmen, and he urged that the superior method of ventilation carried out in the States should be adopted in this country by introducing a fan to each wheel to take away the particles, *etc.*, which were so injurious. One very special feature in the United States was that works were devoted to the manufacture of one particular article to an almost inconceivable extent, and that heavy machine tools complete and ready to be dispatched were kept in stock in large numbers. American enterprise was not hampered as it too frequently was in England by want of capital; while in England we were ready to put our savings in South American railways or fictitious gold mines, but very chary about investing capital which would assist an engineer in bringing out an honest improvement, in America, on the other hand, it was a common practice among the best firms to invest their savings over and over again in their works, which were thus kept in a high state of perfection.

The above paper came in for some pretty severe criticism. Mr. John Craven remarked that although Mr. Renold had gone over a wide field of subjects, he had practically confined his remarks to Messrs. Brown & Sharpe's establishment, and while he (Mr. Craven) was ready to admit that so far as high class work and sanitary arrangements were concerned, Messrs. Brown & Sharpe's were a model, they could not be put forward as representative of American establishments generally. As a matter of fact, many of the American workshops were not as good as a large number of similar workshops in Manchester. Mr. Renold had referred to the extensive use of gear cutters in the United States, but he might point out that it was in Manchester that the milling machine was first made. Mr. Samuel Dixon said he had certainly come to the conclusion that no better work was done in America than could be and was being done in this country; while as regards the enormous production of milling cutters, that was simply an example of what could be done where large firms devoted themselves

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to the production of one specialty. With regard to the statement made by Mr. Renold that the American thread was preferable to the Whitworth thread, he might say he entirely disagreed with such a conclusion, and he might add that after visiting a variety of Continental and American workshops he should certainly not, if he were called upon to award the palm of superiority in workmanship, go across the Atlantic for that purpose. Mr. J. Nasmith remarked that whether English engineers were the inventors of the milling machine or not, it must be admitted that it was through this type of cutter being taken up by the Americans that milling had become the success it was at the present time. English engineers were very conservative, and it was only through the pressure of circumstances that milling machines came into general use in this country. When American inventions were brought to England they were generally improved to the highest degree, but he thought the chief fault of both American and Continental engineers was what one might call "over-refinement;" there was such a thing as over-finishing an object and overdoing it. If, however, American machinery was so much superior to what we had in this country, as asserted by the reader of the paper, how was it that cotton machinery, with all its intricacies, could be sent to the United States, in the face of American manufacturers, even though the cost was increased from 40 to 60 per cent.? At the present time it was possible for English machinists to secure contracts for the whole of the machinery in an American mill, and inclusive of freight charges and high tariff, deliver and erect it in America at a lower cost than American engineers with all the advantages of their immeasurably superior tools were able to do. Another speaker, Mr. Barstow, ridiculed the idea that the Americans could be so pre-eminent in the manufacture of emery wheels as might be inferred from Mr. Renold, when they had before them the fact that from the neighborhood of Manchester thousands of emery wheels were every year exported to the United States.

* * * * *

MODERN METHODS OF QUARRYING.

Mr. Wm. L. Saunders, for many years the engineer of the Ingersoll Rock Drill Co., and hence thoroughly familiar with modern quarrying practice, read a paper before the last meeting of the American Society of Civil Engineers on the above subject, containing many interesting points, given in the *Engineering News*, from which we abstract as follows.

As a preliminary to describing the new Knox system of quarrying, which even yet is not universally known among quarrymen, Mr. Saunders gives the following in regard to older methods:

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The Knox system is a recent invention; no mention was made of it in the tenth census, and no description has yet been given of it in any publications on quarrying. The first work done by this method was in 1885, and at the close of that year 2 quarries had adopted it. In 1886 it was used in 20 quarries; in 1887 in 44, in 1888 in upward of 100, and at the present time about 300 quarries have adopted it. Its purpose is to release dimension stone from its place in the bed, by so directing an explosive force that it is made to cleave the rock in a prescribed line without injury. The system is also used for breaking up detached blocks of stone into smaller sizes.

Quarrymen have, ever since the introduction of blasting, tried to direct the blast so as to save stock. Holes drilled by hand are seldom round. The shape of the bit and their regular rotation while drilling usually produce a hole of somewhat triangular section. It was observed, many years ago, that when a blast was fired in a hand-drilled hole the rock usually broke in three directions, radiating from the points of the triangle in the hole. This led quarrymen to look for a means by which the hole might be shaped in accordance with a prescribed direction of cleavage.

The oldest sandstone quarries in America are those at Portland, Conn. It was from these quarries that great quantities of brownstone were shipped for buildings in New York. The typical "brownstone front" is all built of Portland stone. As the Portland quarries were carried to great depths the thickness of bed increased, as it usually does in quarries. With beds from 10 to 20 ft. deep, all of solid and valuable brownstone, it became a matter of importance that some device should be applied which would shear the stone from its bed without loss of stock and without the necessity of making artificial beds at short distances. A system was adopted and used successfully for a number of years which comprised the drilling of deep holes from 10 to 12 in. in diameter, and charging them with explosives placed in a canister of peculiar shape. The drilling of this hole is so interesting as to warrant a passing notice. The system was similar to that followed with the old fashioned drop drill. The weight of the bit was the force which struck the blow, and this bit was simply raised or lowered by a crank turned by two men at the wheel. The bit resembled a broad ax in shape, in that it was extremely broad, tapering to a sharp point, and convex along the edge.

[Illustration: Fig. 1]

Fig. 1 illustrates in section one of the Portland drills, and a drill hole with the canister containing the explosive in place. The canister was made of two curved pieces of sheet tin with soldered edges, cloth or paper being used at the ends. It was surrounded with sand or earth, so that the effect of the blast was practically the same as though the hole were drilled in the shape of the canister.

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In other words, the old Portland system was to drill a large, round hole, put in a canister, and then fill up a good part of the hole. Were it possible to drill the hole in the shape of the canister, it would obviously save a good deal of work which had to be undone. The Portland system was, therefore, an extravagant one, but the results accomplished were such as to fully warrant its use. Straight and true breaks were made, following the line of the longer axis of the canister section, as in Fig. 2.

[Illustration: Fig. 2.]

It was found that with the old Portland canister two breaks might be made at right angles by a single blast, when using a canister shaped like a square prism. In some of the larger blasts, where blocks weighing in the neighborhood of 2,000 tons were sheared on the bed, two holes as deep as 20 ft. were drilled close together. The core between the holes was then clipped out and large canisters measuring 2 ft. across from edge to edge were used.

In regard to another of the older systems of blasting, known as Lewising, Mr. Saunders says:

A Lewis hole is made by drilling two or three holes close together and parallel with each other, the partitions between the holes being broken down by using what is known as a broach. Thus a wide hole or groove is formed in which powder is inserted, either by ramming it directly in the hole, or by puling it in a canister, shaped somewhat like the Lewis hole trench. A complex Lewis hole is the combination of 3 drill holes, while a compound Lewis hole contains 4 holes. Lewising is confined almost entirely to granite. In some cases a series of Lewis holes is put in along the bench at distances of 10 and 25 ft. apart, or even greater, each Lewis hole being situated equidistant from the face of the bench. The holes are blasted simultaneously by the electric battery.

After noting another system used to a limited extent, and not to be commended, viz., the use of inverted plugs and feathers (the plugs and feathers being inserted as a sort of tamping which the blast drives upward to split the rock), Mr. Saunders continues in substance as follows:

It is thus seen that the "state of the art" has been progressive, though it was imperfect. Mr. Sperr, in his reference to this subject, made in the report of the tenth census, says: "The influence of the shape of the drill hole upon the effects of the blast does not seem to be generally known, and a great waste of material necessarily follows." This was written but a few years before the introduction of the new system, and it is doubtless true that attention was thus widely directed to the conspicuous waste, due to a lack of knowledge of the influence of the shape of a drill hole on the effect of a blast. The system developed by Mr. Knox practically does all and more than was done by the old

Portland system, and it does it at far less expense. It can best be described by illustrations.

[Illustrations: Figs. 3, 4, 5, 6]

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Fig. 3 is a round hole drilled either by hand or otherwise, preferably otherwise, because an important point is to get it round. Fig. 4 is the improved form of hole, and this is made by inserting a reamer, Figs. 5 and 6, into the hole in the line of the proposed fracture, thus cutting two V-shaped grooves into the walls of the hole. The blacksmith tools for dressing the reamers are shown in Fig. 7. The usual method of charging and tamping a hole in using the new system is shown in Fig. 8. The charge of powder is shown at C, the air space at B and the tamping at A. Fig. 9 is a special hole for use in thin beds of rock. The charge of powder is shown at C, the rod to sustain tamping at D, air space at BB, and tamping at A.

[Illustration: Fig. 7]

Let us assume that we have a bluestone quarry, in which we may illustrate the simplest application of the new system. The sheet of stone which we wish to shear from place has a bed running horizontally at a depth of say 10 ft. One face is in front and a natural seam divides the bed at each end at the walls of the quarry. We now have a block of stone, say 50 ft. long, with all its faces free except one—that opposite and corresponding with the bench. One or more of the specially formed holes are put in at such depth and distance from each other and from the bench as may be regulated by the thickness, strength and character of the rock. No man is so good a judge of this as the quarry foreman who has used and studied the effect of this system in his quarry. Great care should be taken to drill the holes round and in a straight line. In sandstone of medium hardness these holes may be situated 10, 12 or 15 ft. apart. If the bed is a tight one the hole should be run entirely through the sheet and to the bed; but with an open free bed holes of less depth will suffice.

[Illustration: Fig. 8, 9]

The reamer should now be used and driven by hand. Several devices have been applied to rock drills for reaming the hole by machinery while drilling; that is, efforts have been made to combine the drill and the reamer. Such efforts have met with only partial success. The perfect alignment of the reamer is so important that where power is used this point is apt to be neglected. It is also a well known fact that the process of reaming by hand is not a difficult or a slow one. The drilling of the hole requires the greatest amount of work. After this has been done it is a simple matter to cut the V-shaped grooves. The reamer should be applied at the center, that is, the grooves should be cut on the axis or full diameter of the hole. The gauge of the reamer should be at least 11/2 diameters. Great care should be taken that the reamer does not twist, as the break may be thereby deflected; and the reaming must be done also to the full depth of the hole.

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The hole is now ready for charging. The powder should be a low explosive, like black or Judson powder or other explosives which act slowly. No definite rule can be laid down as to the amount of powder to be used, but it should be as small as possible. Very little powder is required in most rocks. Hard and fine grained stone requires less powder than soft stone. Mr. Knox tells of a case which came under his observation, where a block of granite "more than 400 tons weight, split clear in two with 13 oz. of FF powder." He compares this with a block of sandstone of less than 100 tons weight "barely started with 21/2 lb. of the same grade of powder, and requiring a second shot to remove it."

It is obvious that enough powder must be inserted in the hole to produce a force sufficient to move the entire mass of rock on its bed. In some kinds of stone, notably sandstone, the material is so soft that it will break when acted upon by the force necessary to shear the block. In cases of this kind a number of holes should be drilled and fired simultaneously by the electric battery. In such work it is usual to put in the holes only 4 or 5 ft. apart. The powder must, of course, be provided with a fuse or preferably a fulminating cap. It is well to insert the cap at or near the bottom of the cartridge, as shown in Figs. 8 and 9.

After the charge the usual thing to do is to insert tamping. In the improved form of hole the tamping should not be put directly upon the powder, but an air space should be left, as shown at B, Fig. 8. The best way to tamp, leaving an air space, is first to insert a wad, which may be of oakum, hay, grass, paper or other similar material. The tamping should be placed from 6 to 12 in. below the mouth of the hole. In some kinds of stone a less distance will suffice, and as much air space as practicable should intervene between the explosive and the tamping. If several holes are used on a line they should be connected in series and blasted by electricity. The effect of the blast is to make a vertical seam connecting the holes, and the entire mass of rock is sheared several inches or more.

The philosophy of this new method of blasting is simple, though a matter of some dispute. The following explanation has been given. See Fig. 10.

[Illustration: Fig. 10]

"The two surfaces, *a* and *b*, being of equal area, must receive an equal amount of the force generated by the conversion of the explosive into gas. These surfaces being smooth and presenting no angle between the points, A and B, they furnish no starting point for a fracture, but at these points the lines meet at a sharp angle including between them a wedge-shaped space. The gas acting equally in all directions from the center is forced into the two opposite wedge-shaped spaces, and the impact being instantaneous the effect is precisely similar to that of two solid wedges driven from the center by a force equally prompt and energetic. All rocks possess the property of elasticity in a greater or less degree, and this principle being excited to the point of

rupture at the points, A and B, the gas enters the crack and the rock is split in a straight line simply because under the circumstances it cannot split in any other way.”

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Another theory which is much the same in substance is then given, and after some general discussion of the theory of the action of the forces under the several systems, the paper continues:

The new form of hole is, therefore, almost identical in principle with the old Portland canister, except that it has the greater advantage of the V-shaped groove in the rock, which serves as a starting point for the break. It is also more economical than the Portland canister, in that it requires less drilling and the waste of stone is less. It is, therefore, not only more economical than any other system of blasting, but it is more certain, and in this respect it is vastly superior to any other blasting system, because stone is valuable, and anything which adds to the certainty of the break also adds to the profit of the quarryman.

It is doubtless true that, notwithstanding the greater area of pressure in the new form of hole, the break would not invariably follow the prescribed line but for the V-shaped groove which virtually starts it. A bolt, when strained, will break in the thread whether this be the smallest section or not, because the thread is the starting point for the break. A rod of glass is broken with a slight jar provided a groove has been filed in its surface. Numerous other instances might be cited to prove the value of the groove. Elasticity in rock is a pronounced feature, which varies to a greater or less extent; but it is always more or less present. A sandstone has recently been found which possesses the property of elasticity to such an extent that it may be bent like a thin piece of steel. When a blast is made in the new form of hole the stone is under high tension, and being elastic it will naturally pull apart on such lines of weakness as grooves, especially when they are made, as is usually the case in this system, in a direction at right angles with the lines of least resistance.

Horizontal holes are frequently put in and artificial beds made by "lofting." In such cases where the rock has a "rift" parallel with the bed, one hole about half way through is sufficient for a block about 15 ft. square, but in "liver" rock the holes must be drilled nearly through the block and the size of the block first reduced.

A more difficult application of the system, and one requiring greater care in its successful use, is where the block of stone is so situated that both ends are not free, one of them being solidly fixed in the quarry wall. A simple illustration of a case of this kind is a stone step on a stairway which leads up and along a wall, Fig. 11. Each step has one end fixed to the wall and the other free. Each step is also free on top, on the bottom and on the face, but fixed at the back. We now put one of the new form of holes in the corner at the junction of the step and the wall. The shape of the hole is as shown in Fig. 12.

[Illustration: FIG. 11.]

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It is here seen that the grooves are at right angles with each other, and the block of stone is sheared by a break made opposite and parallel with the bench, as in the previous case, and an additional break made at right angles with the bench and at the fixed end of the block. Sometimes a corner break is made by putting in two of the regular V-shaped holes in the lines of the proposed break and without the use of the corner hole. A useful application of this system is in splitting up large masses of loose stone. For this purpose the V-shaped grooves are sometimes cut in four positions and breaks are made in four directions radiating from the center of the hole as shown in Fig. 12. In this way a block is divided into four rectangular pieces.

[Illustration: FIG. 12.]

Though the new system is especially adapted to the removal of heavy masses of rock, yet it has been applied with success in cases where several light beds overlie each other. In one such instance 10 sheets, measuring in all only 6 ft., were broken by a blast, but in cases of this kind the plug and feather process applies very well, and the new system, when used, must be in the hands of an expert, or the loss will be serious.

Referring again to our stone step, let us imagine a case where this stairway runs between two walls. We have here each step fixed at each end and free only on the top, the bottom, and one face. Let us assume that there is a back seam, that is, that the step is not fixed at the back. In a quarry, this seam, unless a natural one, should be made by a channeling machine. In order to throw this step put of place it must be cut off at both ends, and for this purpose the V-shaped holes are put in at right angles to the face. It is well, however, to put the first two holes next the back seam in a position where the grooves will converge at the back so as to form a sort of key, which serves a useful purpose in removing the block after the blast. In quarries where there are no horizontal beds a channeling machine should be used to free the block on all sides and to a suitable depth, and then the ledge may be "lofted" by holes placed horizontally.

Where "pressure" exists in quarries, the new system has certain limitations. After determining the line of "pressure" it is only practicable to use the system directly on the line of thrust, or at right angles to it. It is much better, however, to release the "pressure" from the ledge by channeling, after which a single end may be detached by a Knox blast. It is well to bear in mind that the holes should invariably be of small diameter. In no case should the diameter of a hole be over 1 1/2 in. in any kind of rock. This being the case, the blocks of stone are delivered to the market with but little loss in measurement. It is a noticeable fact that stone quarried by the new system shows very little evidence of drill marks, for the faces are frequently as true as though cut with a machine.

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A further gain is the safety of the system. The blasting is light and is confined entirely within the holes. No spalls or fragments are thrown from the blast.

The popular idea that the system is antagonistic to the channeling process is a mistaken one. There are, of course, some quarries which formerly used channeling machines without this system, but which now do a large part of the work by blasting. Instances, however, are rare where the system has replaced the channeler. The two go side by side, and an intelligent use of the new system in most quarries requires a channeling machine. There are those who may tell of stone that has been destroyed by a blast on the new system, but investigation usually shows that either the work was done by an inexperienced operator, or an effort was made to do too much.

A most interesting illustration of the value of this system, side by side with the channeler, is shown in the northern Ohio sandstone quarries. A great many channeling machines are in use there, working around the new form of holes, and when used together in an intelligent and careful manner, the stone is quarried more cheaply than by any other process that has yet been devised.

To a limited extent the system has been used in slate. The difficulty is that most of the slate quarries are in solid ledges, where no free faces or beds exist; but it has been used with success in a slate quarry at Cherryville, Pa., since 1888. Among notable blasts made by this system are the following: At the mica schist quarries, at Conshohocken, Pa., a hole 11/2 in. in diameter was drilled in a block which was 27 ft. long, 15 ft. wide and 6 ft. thick. The blast broke the stone across the "rift," only 8 oz. of black powder being used. At the Portland, Conn., quarries a single blast was fired by electricity, 15 holes being drilled with 2 lb. of coarse No. C powder in each hole, and a rock was removed 110 ft. long, 20 ft. wide and 11 ft. thick, containing 24,200 cu. ft., or about 2,400 tons, the fracture being perfectly straight. This large mass of stone was moved out about 2 in. without injury to itself or the adjoining rock.

Another blast at Portland removed 3,300 tons a distance of 4 in. Seventeen holes were drilled, using 2 lb. of powder in each hole, the size of the block being 150 x 20 x 11 ft. In a Lisbon, O., quarry a block of sandstone 200 ft. long, 28 ft. wide and 15 ft. thick was moved about 1/2 in. by a blast. This block was also afterward cut up by this system in blocks 6 ft. square. A sandstone boulder 70 ft. long, average width 50 ft., average thickness 13 ft., was embedded in the ground to a depth of about 7 ft. A single hole 8 ft. deep was charged with 20 oz. of powder and the rock was split in a straight line from end to end and entirely to the bottom. A ledge of sandstone open on its face and two ends, 110 x 13 x 8 ft., was moved by a blast about 3 in. without wasting a particle of rock, 8 holes being used, drilled by three men in just one day, and 15 oz. of powder being used in each hole. A sandstone ledge, open on the face and end only, 200 x 28 x 15 ft., containing 84,000 cu. ft. stone, was moved 1/2 in. by 25 holes, each containing 1 lb. of powder.

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THE TROTTER CURVE RANGER.

This little instrument was exhibited in a somewhat crude state at the meeting of the British Association at Newcastle in 1889. It has since been modified in several respects, and improvements suggested by practical use have been introduced, bringing it into a practical form, and enabling a much greater accuracy to be attained. The principle is one which is occasionally employed for setting out circles with a pocket sextant, viz., the property of a circle that the angle in a segment is constant. The leading feature of the invention is the arrangement of scales, which enables the operation of setting out large curves for railway or other work to be carried out without requiring any calculations, thereby enabling any intelligent man to execute work which would otherwise call for a knowledge of the use of a theodolite and the tables of tangential angles.

[Illustration: FIG. 1—PERSPECTIVE VIEW OF INSTRUMENT MOUNTED ON A STAFF.]

The instrument is intended to be thoroughly portable; so much so, indeed, that it is not necessary or even desirable to use a tripod. It may be held in the hand like a sextant, or may be carried on a light staff. The general appearance is shown in Fig. 1. It will be seen that a metal plate, on which two scales are engraved, carries a mirror at one end and an eye piece at the other. The mirror is mounted on a metal plate, which is shaped to a peculiar curve. A clamp and slow motion provide for rapid and for fine adjustment. The eye piece is set at an angle, and contains a half silvered mirror, the upper portion being transparent. This allows direct vision along the axis of the eye piece, and at the same time vision in another direction, after two reflections, one in the eye piece and the other at the adjustable mirror. Fig. 2 is an outline plan of the instrument when closed. In the first form of the instrument only one mirror was provided, but by the double reflection in the improved pattern, any accidental twisting of the rod or handle produces no displacement of the images, since the inclination of one mirror neutralizes the equal and opposite inclination of the other. No cross line is required with the new arrangement, since it is only necessary that the two images should coincide.

[Illustration: FIG. 2.—OUTLINE OF INSTRUMENT SHOWING THE PATH OF THE DIRECT AND OF THE REFLECTED RAY.]

The dotted line A B represents the direct ray, and the line A C D the reflected one. Fig. 3 shows the different geometrical and trigonometrical elements of the curve, which can be read upon the various scales, or to which the instrument may be set. An observer standing at C sights the point B directly and the point A by reflection. A staff being set

up at each point, he will see them simultaneously, and in coincidence if the instrument be properly set for the curve.

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If any intermediate position be taken up on the curve, both A and B will be seen in coincidence. If the two rods do not appear superimposed, the operator must move to the right or the left until this is the case. The instrument will then be over a point in the curve. Any number of points at any regular or irregular distances along the curve can thus be set out. One of the simplest elements which can be taken as a datum is the ratio of the length of the chord to the radius, AB/AO, Fig. 3. This being given, the value of the ratio is found on the straight scale on the body of the instrument, and the curved plate is moved until the beveled edge cuts the scale at the desired point. The figure of this curve is a polar curve, whose equation is $r = a \pm b \sin. 2 [\theta]$, where a is the distance from the zero graduation to the axis of the mirror, and b is the length of the scale from zero to 2, and $[\theta]$ is the inclination of the mirror. In the perspective view, Fig. 1, the curved edge cuts the scale at 1. The instrument being thus set, the following elements may be read either directly on the scales or by simple arithmetical calculation:

[Illustration: FIG. 3]

The radius = 1.

AB, the chord, read direct on the straight scale.

AFB, the length of the arc, read direct on the back or under surface of the plate.

FH, the versed sine, read direct on the curved scale.

ACB, the angle in the segment, read direct on the graduated edge.

EAB, the angle between the chord and the tangent, read direct on the graduated edge.

GAB, the tangential angle = $180 \text{ deg.} - \text{ACB}$.

AOB, the angle at the center = 2GAB .

AGB, the angle between the tangents = $180 \text{ deg.} - \text{AOB}$.

OAB, the angle between the chord and the radius = $\text{EAB} - 90 \text{ deg.}$

$\text{AH}_{\{2\}}$
 $\text{GF} = \text{-----} - \text{FH}$.

HO

The foregoing elements are contained in a very simple diagram, Fig. 4, which is engraved on the instrument, together with the following references:

$$B = 180 \text{ deg.} - A.$$

$$C = 2B.$$

$$D = 180 \text{ deg.} - C.$$

$$E = A - 90.$$

Only one adjustment is necessary, and this is provided by means of the screws which fix the inclination of the eyepiece. This is set at such an angle that the instrument, when closed and reading 90 deg. on the divided limb, acts as an optical square.

It is not necessary, as in the ordinary method with a theodolite, that one end of the curve should be visible from the other. If an obstacle intervenes, all that part of the curve which commands a view of both ends can be set out, and a ranging rod can be set up at any point of the curve so found, and the instrument may be reset to complete the curve.

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To set out a tangent to the curve at A, Fig. 3, set up a rod at A and another at any point C, and take up a position on the curve at some point between them. Adjust the mirror until the rods are seen superimposed. Then moving back to A, observe C direct, and set up a rod at E in the line observed by reflection. Then A E is the tangent required. Similarly, on completing the setting out of a curve, and arriving at the end of the chord, the remote end being seen by reflection, the direction observed along the axis of the eyepiece is the new tangent.

Any of the angles or other ratios already mentioned may be used for setting the instrument, but if no data whatever are given, as in the rough surveys for colonial railways where no previous surveys exist, it is only necessary to select points through which the curve must pass, to set up ranging rods either at the extremities of the desired curve, or at any points thereon, to take up a position on the desired curve between two rods, and to adjust the instrument until they are seen in coincidence. The curve can then be set out, and fully marked, and the elements of the curve can be read on the scales and recorded for reference.

[Illustration: FIG. 4.—DIAGRAM ENGRAVED ON THE INSTRUMENT.]

Various other cases which may occur in practice can be rapidly met by one or other of the various scales. Suppose the angle A G B between the tangents be given, together with the middle point F on the curve, Fig. 3. Subtract this angle from 180 deg., the difference gives the angle at the center A O B. Take half this, and set the instrument to the angle thus found. Walk along the tangent until a rod set up at some point in the tangent, say E, is seen in coincidence with a rod set up at B. The position of the instrument then marks the point of departure A. A rod being placed at A, the first half of the curve may be set out; or, if B is invisible, the instrument may be reset for the angle E A B, and the whole curve set out up to B. No cutting of hedges is necessary, as with theodolite work, for a curve can easily be taken piece by piece. Inclination of the whole instrument introduces no appreciable error. If the eye piece be pointed up or down hill, the instrument is thrown a little to one side or other of the tip of the staff, but in a plane tangent to the circle. Errors made in setting out a curve with the Trotter curve ranger are not cumulative, as in the method of tangential angles with a theodolite. No corrections for inaccurate hitting of the final rod can occur, for the curve must necessarily end at that point. It should be observed that the instrument is not intended to supersede a theodolite, but it has the great advantage over the older instrument that no assistant or chains or trigonometrical tables or any knowledge of mathematics are required. The data being given, by a theodolite or otherwise, an intelligent platelayer can easily set out the curve, while the trained engineer proceeds

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in advance with the theodolite. No time is lost; as in chaining, since the marks may be made wherever and as often as convenient. In work where high accuracy is required this instrument is well adapted for filling in, and where a rough idea of the nature of a given curve is required, the mirror being adjusted for any three points upon it, the various elements may be read off on the scales. A telescope is provided, but the errors not being cumulative, it is rarely required. The curve ranger weighs 1 lb. 10 oz., and is manufactured by Messrs. Elliott Bros., St. Martin's Lane, London. It is the invention of Mr. Alex. P. Trotter, Westminster.—*The Engineer*.

* * * * *

THE RAIL SPIKE AND THE LOCOMOTIVE.[1]

[Footnote 1: Abstract from the History of the Camden and Amboy Railroad. By J. Elfreth Watkins, of the National Museum, Washington, D.C.]

Early in October, 1830, and shortly after the surveys of the Camden and Amboy Railroad were completed, Robert L. Stevens (born 1787) sailed for England, with instructions to order a locomotive and rails for that road.

At that time no rolling mill in America was able to take a contract for rolling T rails.

Robert Stevens advocated the use of an all-iron rail in preference to the wooden rail or stone stringer plated with strap iron, then in use on one or two short American railroads. At his suggestion, at the last meeting held before he sailed, after due discussion, the Board of Directors of the Camden and Amboy Railroad passed a special resolution authorizing him to obtain the rails he advocated.

ROBERT L. STEVENS INVENTS THE AMERICAN RAIL AND SPIKE.

During the voyage to Liverpool he whiled away the hours on shipboard by whittling thin wood into shapes of imaginary cross sections until he finally decided which one was best suited to the needs of the new road.

He was familiar with the Berkenshaw rail, with which the best English roads were then being laid, but he saw that, as it required an expensive chair to hold it in place, it was not adapted to our country, where metal workers were scarce and iron was dear. He added the base to the T rail, dispensing with the chair. He also designed the "hook-headed" spike (which is substantially the railroad spike of to-day) and the "iron tongue"

(which has been developed into the fish bar), and the rivets (which have been replaced by the bolt and nut) to complete the joint.

A fac-simile of the letter[2] which he addressed to the English iron masters a short time after his arrival in London is preserved in the United States National Museum. It contains a cross section, side elevation and ground plan of the rail for which he requested bids.

The base of the rail which he first proposed was to be wider where it was to be attached to the supports than in the intervening spaces. This was afterward modified, so that the base was made the same width (three inches) throughout.

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[Footnote 2: This letter reads:

LIVERPOOL, November 26th, 1830.

GENTLEMEN,—At what rate will you contract to deliver at Liverpool, say from 500 to 600 tons of railway, of the best quality of iron rolled to the above pattern in 12 or 16 feet lengths, to lap as shown in the drawing, with one hole at each end, and the projections on the lower flange at every two feet, cash on delivery? How soon could you make the first delivery, and at what rate per month until the whole is complete? Should the terms suit and the work give satisfaction a more extended order is likely to follow, as this is but about one-sixth part of the quantity required. Please to address your answer (as soon as convenient) to the care of Francis B. Ogden, Consul of the United States at Liverpool.

I am

Your obedient servant,
ROBERT L. STEVENS,
*President and Engineer of the Camden and
South Amboy Railroad and Transportation Company.]*

DIFFICULTY OF ROLLING THE AMERICAN RAIL.

Mr. Stevens received no favorable answer to his proposals, but being acquainted with Mr. Guest (afterward Sir John Guest), a member of Parliament, proprietor of large iron works in Dowlais, Wales, he prevailed upon him to have rails rolled at his works. Mr. Guest became interested in the matter and accompanied Mr. Stevens to Wales, where the latter gave his personal supervision to the construction of the rolls. After the rolls were completed the Messrs. Guest hesitated to have them used, through fear of damage to the mill machinery, upon hearing which Mr. Stevens deposited a handsome sum guaranteeing the expense of repairing the mill in case it was damaged. The receipt for this deposit was preserved for many years among the archives of the Camden and Amboy Company. As a matter of fact, the rolling apparatus did break down several times. "At first," as Mr. Stevens in a letter to his father, which I have seen, described it, "the rails came from the rolls twisted and as crooked as snakes," and he was greatly discouraged. At last, however, the mill men acquired the art of straightening the rail while it cooled.

The first shipment,[3] consisting of five hundred and fifty bars eighteen feet long, thirty-six pounds to the yard, arrived in Philadelphia on the ship Charlemagne, May 16, 1831.

Over thirty miles of this rail was laid before the summer of 1832.

A few years after, on much of the Stevens rail laid on the Camden and Amboy Railroad, the rivets at the joints were discarded, and the bolt with the screw thread and nut, similar to that now used, was adopted as the standard.

The rail was first designed to weigh thirty-six pounds per yard, but it was almost immediately increased in weight to between forty and forty-two pounds, and rolled in lengths of sixteen feet. It was then three and a half inches high, two and one-eighth inches wide on the head and three and a half inches wide at the base, the price paid in England being L8 per ton. The import duty was \$1.85.

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The first shipment of rail, having arrived in America, was transported to Bordentown, and here, upon the ground on which we stand, and which this monument is erected to mark forever, was laid the first piece of track (about five-sixths of a mile long) in August, 1831. The Camden and Amboy Company, following the example of the Manchester and Liverpool Railroad, laid their first track upon stone blocks two feet square and ten to thirteen inches deep. These blocks were purchased from the prison authorities at Sing Sing, N.Y. Some of these stone blocks have been used in constructing the foundation for this monument.

[Footnote 3: A list of the vessels chartered to transport the rails, with dates, tonnage, etc., is given below:

No. of Date.	Tonnage. Ship.	Rate of Bars.	tons.	cwt.	lb.	Duty.
May 16, 1831.	Charlemagne	550	504	0	14	\$1.85
May 19, 1831.	Salem	963	744	2	14	1.85
April 7, 1832.	Caledonia	38	63	3	07	1.85
April 23, 1832.	Armadilla	525	1,000	3	21	1.85
May 4, 1832.	George Clinton	624	986	2	14	1.85
June 2-18, 1833.	Henry Kneeland	204	377	3	21	1.85
May 8, 1832.	Cumberland	1,464	2,790	1	00	1.85
June 2, 1832.	Gardiner	601	1,136	0	00	1.85
June 5, 1832.	Globe	499	943	1	14	1.85
June 6, 1832.	Jubilee	70	130	0	21	1.85
July 18, 1832.	Hellen	1,080	2,004	3	21	1.85
July 19, 1832.	Nimrod	937	1,745	3	00	1.85
Aug. 2, 1832.	Emery	240	454	2	00	1.85
Aug. 7, 1833.	Ajax	364	700	0	21	1.85
Aug. 13, 1832.	Concordia	622	1,174	3	14	1.85
Aug. 14, 1830.	William Byrny	1,120	2,138	1	07	1.85
Aug. 20, 1832.	Mary Howland	932	1,755	3	07	1.85
Aug. 23, 1832.	Pulaski	488	924	1	00	1.85
Aug. 24, 1832.	Robert Morris	1,985	3,732	0	14	1.85
Aug. 27, 1832.	Ann	506	961	2	27	1.85
Sept. 3, 1832.	Montgomery	1,369	2,959	0	14	1.85
Sept. 4, 1832.	Marengo	534	1,004	2	07	1.85
Oct. 12, 1832.	Vestal	237	460	2	07	1.85

This iron proved to be of such superior quality that after it was worn out in the track, the company's mechanics preferred it to new iron in making repairs. Some of this rail is still in use in side tracks. It is pronounced equal in durability to much of the steel rail of to-day.]

FIRST JOINT FIXTURES.

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Mr. Stevens ordered the first joint fixtures also from an English mill, at the same time. The ends of the rails were designed to rest upon wrought iron plates or flat cast plates. The rails were connected at the stems by an iron “tongue” five inches long, two inches wide, and five-eighths of an inch thick. A rivet, put on hot, passing through the stem of each rail near the ends of the bar, fastened it to the tongue and completed the joint. A hole oblong in shape, to allow for expunctral contraction, was punched in the stem at each end of the rail.

THE FIRST RAILROAD SPIKES.

The first “spikes six inches long, with hooked heads,” were also ordered at the same time. These were undoubtedly the “first railroad spikes” (as they are known to the trade) ever manufactured.

Mr. Stevens neglected to obtain a patent for these inventions, although urged to do so by Mr. Ogden, American Consul at Liverpool, and the credit of being the inventor of the American rail was for a time claimed for others, but the evidence brought forward in late years fully established the fact that he was the originator of the American system of railway construction.

The “Stevens rail and spike” gradually found great favor everywhere in America—all the roads being relaid with it as the original T or strap rail became worn out.

In England the T rail still continues to be used. The London and Birmingham Railway, opened in 1838, was laid with Berkenshaw rails; part with the straight and part with the fish-bellied rail, and the remainder with reversible “bull-headed” rail, both types being supported by chairs.[4]

[Footnote 4: The experiment of laying the Stevens rail in chairs was tried on the Albany and Schenectady road in 1837, on the Hudson River Railroad 1848, but the chairs were soon afterward discarded, nothing but spikes being used to attach the rail to the tie.]

Sixty years have elapsed since this rail was adopted by the Camden and Amboy Company, and with the exception of slight alterations in the proportions incident to increased weight, no radical change has been made in the “Stevens rail,” which is now in use on every railroad in America. Many improvements have been made in the joint fixture, but the “tongue” or fish plate improved into the angle splice bar is in general use, and nothing has yet been found to take the place of the “hook-headed” railroad spike which Robert Stevens then designed.

The track upon which we stand was the first in the world that was laid with the rail and spike now in general use.

MR. STEVENS EXAMINES ENGLISH LOCOMOTIVES.

Mr. Stevens divided his time while abroad between arranging for the manufacture of track material and examining the English locomotives that were being constructed or had been in service.

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A year had elapsed since the opening of the Liverpool and Manchester Railway, and the English mechanics had not been idle. The “Rocket,” although successful in the Rainhill contest, when put to work had shown many defects that Stephenson & Co. were striving to correct in subsequent locomotives.

The “Planet,” built by that firm, was tried in public December 4, 1830, shortly after Mr. Stevens arrived in England, and at that time was undoubtedly the best locomotive in the world.

THE “JOHN BULL” ORDERED.

Mr. Stevens was present at a trial when the “Planet” showed most satisfactory properties, and he at once ordered a locomotive of similar construction, from the same manufacturers, for the Camden and Amboy Railroad. This engine, afterward called the “John Bull” and “No. 1,” was completed in May and shipped by sailing vessel from Newcastle-on-Tyne in June, 1831, arriving in Philadelphia about the middle of August of that year. It was then transferred to a sloop at Chestnut Street wharf, Philadelphia, whence it was taken to Bordentown.

THE “JOHN BULL” ARRIVES AT BORDENTOWN.

The following circumstances connected with the arrival of the engine at Bordentown, N.J., are related by Isaac Dripps, Esq., for many years master mechanic of the Camden and Am boy Railroad, and afterward superintendent of motive power of the Pennsylvania Railroad, who is now, after a busy life, enjoying a peaceable retirement at his pleasant home in West Philadelphia.

Mr. Dripps, who is now in the eighty-second year of his age, was employed by Robert and Edwin Stevens in repairing and assisting with their steamboats on the Delaware River and at Hoboken as early as 1829. When the “John Bull” arrived in Philadelphia he was detailed by Robert Stevens to attend to the transportation of the engine to Bordentown, where it was landed safely the last week in August, 1831.

The boiler and cylinders were in place, but the loose parts—rods, pistons, valves, *etc.*—were packed in boxes. No drawings or directions for putting the engine together had come to hand, and young Dripps, who had never seen a locomotive, found great difficulty in discovering how to put the parts in place, alone and unassisted, as Robert Stevens, who had returned from Europe, was absent at Hoboken at the time attending to other matters.

DIMENSIONS OF ENGINE AND PARTS.

The bronze bass-relief upon the monument, made from the working drawing furnished by Mr. Dripps, is an exact representation of the locomotive when it arrived in America.

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The engine originally weighed about ten tons. The boiler was thirteen feet long and three feet six inches in diameter. The cylinders were nine inches by twenty inches. There were four driving wheels, four feet six inches in diameter, arranged with outside cranks for connecting parallel rods, but owing to the sharp curves on the road these rods were never used. The driving wheels were made with cast iron hubs and wooden (locust) spokes and felloes. The tires were of wrought iron, three quarters of an inch thick, the tread being five inches and the depth of flange one and a half inches. The gauge was originally five feet from center to center of rails. The boiler was composed of sixty-two flues seven feet six inches long, two inches in diameter; the furnace was three feet seven inches long and three feet two inches high, for burning wood. The steam ports were one and one-eighth inches by six and a half inches; the exhaust ports one and one-eighth by six and a half inches; grate surface, ten feet eight inches; fire box surface, thirty-six feet; flue surface, two hundred and thirteen feet; weight, without fuel or water, twenty-two thousand four hundred and twenty-five pounds.

After the valves were in gear and the engine in motion, two levers on the engineman's side moved back and forth continuously. When it was necessary to put the locomotive on the turntable, enginemen who were skilled in the handling of the engines first put the valves out of gear by turning the handle down, and then worked the levers by hand, thus moving the valves to the proper position and stopping the engine at the exact point desired.

The reversing gear was a very complicated affair. The two eccentrics were secured to a sleeve or barrel, which fitted loosely on the crank shaft, between the two cranks, so as to turn freely. A treadle was used to change the position of this loose eccentric sleeve on the shaft of the driving wheel (moving it to the right or left) when it was necessary to reverse. Two carriers were secured firmly to the body of this shaft (one on each side of the eccentrics); one carrier worked the engine ahead, the other back. The small handle on the right side of the boiler was used to lift the eccentric rod (which passed forward to the rock shaft on the forward part of the engine) off the pin, and thus put the valves out of gear before it was possible to shift the sleeve and reverse the engine.

Great similarity will be noticed in the American locomotives built for many years after the arrival of the "John Bull," especially in the matter of making the keys, brasses, *etc.*, on the connecting rods, and in the construction of valves, fire box and tubes. Even the old plan of setting the ends of the exhaust nozzle high up in the smoke box, which was discontinued when the petticoat pipe came in use, is now again resorted to in connection with the extended smoke box of modern locomotives.

FIRST TRIAL OF THE LOCOMOTIVE.

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Mr. Dripps informs me that, after many attempts, he succeeded in putting the parts of the engine together, and when it was placed in position upon the track he notified Robert Stevens of the fact. Mr. Stevens came at once to Bordentown, as his anxiety to see it in operation was very great. Upon his arrival the boiler was pumped full of water, by hand, from the hogshead in which it was brought. Benjamin Higgins made the fire with pine wood, and when the scale^[5] showed thirty pounds steam pressure, Isaac Dripps opened the throttle, Robert Stevens standing by his side, and the first locomotive on this great highway *moved*. It would be difficult to describe the feeling of these three men as they stood upon the moving engine—the first human freight drawn by steam on what was afterward destined to be the great highway connecting the two most populous cities of the American continent; a most important link in the chain of intercommunication between the North and South and West. What possibilities must have dawned upon them if they cared to lift the veil of the future!

[Footnote 5: The dial gauge was not in use at that time.]

During the next few days after this preliminary trial the engine was again taken apart, and as a few of the parts needed modification some time intervened before it was again in running order. It will be remembered that young Dripps had never seen a locomotive before and there were no “old engineers” to consult in regard to the construction or management of the engine.

A TENDER IMPROVISED.

As no tender came with the locomotive, one was improvised from a four-wheel flat car that had been used on construction work, which was soon equipped to carry water and wood. The water tank consisted of a large whisky cask which was procured from a Bordentown storekeeper, and this was securely fastened on the center of this four-wheeled car. A hole was bored up through the car into the barrel and into it a piece of two-inch tin pipe was fastened, projecting below the platform of the car. It now became necessary to devise some plan to get the water from the tank to the pump and into the boiler around the turns under the cars, and as a series of rigid sections of pipe was not practicable, young Dripps procured four sections of hose two feet long, which he had made out of shoe leather by a Bordentown shoemaker. These were attached to the pipes and securely fastened by bands of waxed thread. The hogshead was filled with water, a supply of wood for fuel was obtained, and the engine and tender were ready for work.

STEAM OR HORSE POWER?

At that time the question whether the railroad should be operated by steam locomotives or horse power had already become a political issue. The farmers and other horse

owners and dealers, who had made money by selling hay and grain and horses to the stage and freight wagon lines, were discussing the possibilities of loss of business.

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TRIAL OF THE ENGINE BEFORE THE LEGISLATURE.

Many of the members of the New Jersey Legislature were farmers. The management of the Camden and Amboy Railroad was anxious to give these gentlemen and other prominent citizens an opportunity to examine a steam locomotive at work and to ride in a railway train.

Sixty years ago to-day, on the 12th of November, 1831, by special invitation, the members of the Legislature and other State officials were driven from Trenton to Bordentown in stages to witness the trial. Among them were John P. Jackson (father of the present general superintendent of the United Railroads of New Jersey division of the Pennsylvania Railroad, who afterward took a prominent part in the affairs of the New Jersey Railroad, whose termini were at New Brunswick and Jersey City); Benjamin Fish (director for fifty years for the Camden and Amboy Railroad), afterward president of the Freehold and Jamesburg Agricultural Railroad; Ashbel Welch, chief engineer and superintendent of the Belvidere and Delaware Railroad for many years, and president of the United Railroads of New Jersey during the years immediately preceding the lease to the Pennsylvania Railroad; Edwin A. and Robert L. Stevens, afterward managers of the road.

FIRST CARS.

Two coaches built so that they might be drawn by horses were attached to the locomotive. These coaches were of the English pattern. They had four wheels and resembled three carriage bodies joined together, with seats in each facing each other. There were three doors at each side. These cars were made by a firm of carriage manufacturers, M.P. and M.E. Green, of Hoboken, and were thought to be very handsome. The New Jersey law makers were somewhat dubious, it is said, about risking their lives in this novel train, but at last they concluded to do so and the train started and made many trips back and forth without accident or delay. Madam Murat, wife of Prince Murat, a nephew of Napoleon Bonaparte, who was then living in Bordentown, insisted on being the first woman to ride on a train hauled by a steam locomotive in the State.

In the evening a grand entertainment was given to the Legislature by the railroad company at Arnell's Hotel, Bordentown, and it has been whispered that the festivities kept up until a late hour in the night. Whether that be true or not, it is generally conceded that from that time to this the Legislature of New Jersey have always been more or less interested in the affairs of the Camden and Amboy Railroad and its successors, or *vice versa*.

This first movement of passengers by steam in the State of New Jersey was regarded as a success from every point of view, and in commemoration of the important events here enacted the boundaries of this first piece of railway laid between New York and Philadelphia, which were identified and staked out by Isaac Dripps a half century afterward, have been definitely marked for all time by the Pennsylvania Railroad Company, who have erected these handsome stones.

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EARLY DIFFICULTIES.

Among the earliest troubles of the young engineer and his employer, Robert L. Stevens, was the fact that as there were only four wheels under the engines, they were derailed frequently in going around curves; so it was necessary to provide an appliance to prevent this.

THE FIRST PILOT.

The first pilot was planned, 1832, by Robert L. Stevens. A frame made of oak, eight by four feet, pinned together at the corners, was made. Under one end of it a pair of wheels twenty-six inches in diameter were placed in boxes, and the other end was fastened to an extension of the axle outside of the forward driving wheels, it having been found by experience that a play of about one inch on each side on the pedestals of the front wheels of the pilot or engine was necessary in order to get around the curves then in the tracks. For years afterward there was very little change in constructing the pilots from that originally applied to the "John Bull."

The spiral spring, which held the front wheels of the pilot in place, acted substantially as the center pin of a truck. The turntables in use on the road were so short that it was necessary to unconnect and take off these pilots before turning the engine. After the pilot was adopted the forward large wheel on right of the engine was made loose on the shaft in order to afford additional play in going around curves. Other[6] changes and additions were also made in the locomotive.

[Footnote 6: Changes in the locomotive "John Bull" since date of construction, 1830:

Steam dome changed from rear of boiler forward to a part over what was called the "man-hole," and throttle valve placed therein.

Steam pipes changed to outside of boiler, connecting new dome with smoke box, entering it on each side.

In the beginning the reverse gear was changed from one single eccentric rod on each side to two on each side, connecting on to the same eccentric wheel, and the lifting rod, in pulling back, lifted the forward gear hook off the rocker arm, and the back motion hook then connecting on the rocker arm reversed the engine.

Side rods were never used.

Driver spring was changed from a bearing under the pedestal boxes to a point over the boxes.

The pilot was attached in this manner:

Right forward wheel being loose, forward axle extended eight inches beyond box on each side; to this was attached the beam of the pilot, having play of about one inch between box and pedestal plate to act while going around curves. The weight of forward part of engine rested upon a cross brace of the two-wheel pilot, which took bearing by a screw pin surrounded by a spring, by turning which pin the weight on the drivers could be adjusted.

A brace used as a hand rail was added on top of the frame, bracing frame and acting as a guide to the driving springs.

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Water-cocks changed from right to left side of the boiler.

Bell, whistle and headlight were added.

Balance safety valve scale was changed forward to a point over barrel of boiler, the secret valve being over the new dome.]

IMPROVEMENTS IN LOCOMOTIVE BUILDING.

During 1831-35 the company's shops were located at Hoboken, N.J., and during the winter of 1832-33, three locomotives were commenced at these shops (two completed before March, 1833, the other in April), the valves, cylinders, pistons, *etc.*, coming from England, the boilers being made under the direction of Robert L. Stevens. It was his opinion that the "John Bull" was too heavy, and the new boilers were built smaller and lighter, so that the engines, when completed, weighed eight instead of ten tons. With these three engines, which were delivered to the railroad company at South Amboy, the stone blocks and other material for the permanent track was delivered along the line of the road.

BALDWIN'S FIRST LOCOMOTIVES.

The importation of the locomotive "John Bull" was destined to have a far-reaching influence in moulding the types of early American locomotives.

After the demonstration of November 12, 1831, the engine was taken from the track and stored in a shed constructed to protect it until such time as the track should be completed.

It was about this time that the proprietor of Peale's Museum, in Philadelphia, applied to Matthias Baldwin, an ingenious mathematical instrument maker, for a small locomotive to run upon a circular track on the floor of the museum. Mr. Baldwin had heard of this locomotive. He came to Bordentown and applied to Isaac Dripps for permission to inspect it. Mr. Dripps tells me he remembers very well the day that he explained to Mr. Baldwin the construction of the various working parts.

Mr. Baldwin built a toy engine for Mr. Peale, which was so successful, that in 1832 he was called upon by the Philadelphia and Germantown Railroad Company to construct the old "Ironsides,"[7] which was similar in many ways to the "John Bull," as an examination of the model preserved in the National Museum will show. The success of this engine laid the foundation for the great Baldwin Locomotive Works, which is in existence to-day, sending locomotives to every part of the globe.



[Footnote 7: A handsome model of the “Ironsides” was presented to the United States National Museum by the Baldwin Locomotive Company in 1888.]

THE LINE FROM BORDENTOWN TO SOUTH AMBOY.

The Camden and Amboy Company having obtained control of the steamboat routes between Philadelphia and Bordentown, and between South Amboy and New York, directed their energies to completing the railway across the State.

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Although the grading of the road from Bordentown to Camden had been commenced in the summer of 1831, work on that end of the line was abandoned for about two years, the entire construction force being put on the work between Bordentown and South Amboy.

The road from Bordentown to Hightstown was completed by the middle of September, 1832, and from Hightstown to South Amboy in the December following. The “deep cut” at South Amboy, and the curves of the track there, gave the civil engineers great trouble.

THE FIRST AMERICAN STANDARD TRACK.

The laying of the track through the “deep cut” led to an event of great importance to future railway construction. The authorities at Sing Sing having failed to deliver the stone blocks rapidly enough, Mr. Stevens ordered hewn wooden cross ties to be laid temporarily, and the rail to be directly spiked thereto. A number of these ties were laid on the sharpest curves in the cut. They showed such satisfactory properties when the road began to be operated that they were permitted to remain, and the stone blocks already in the track were replaced by wooden ties as rapidly as practicable. Without doubt the piece of track in “deep cut” was the first in the world to be laid according to the present American practice of spiking the rail directly to the cross tie.

THE LINE OPENED BETWEEN BORDENTOWN AND SOUTH AMBOY.

Among the memoranda compiled by Benjamin Fish, published in his memoir, I find the following:

“First cars were put on the Camden and Amboy Railroad September 19, 1832. They were drawn by two horses. They took the directors and a few friends from Bordentown to Hightstown and back.

“On December 17, 1832, the first passengers were taken from Bordentown through to South Amboy. Fifty or sixty people went. It was a rainy day.

“On January 24, 1833, the first freight cars were put on the railroad. There were three cars, drawn by one horse each, with six or seven thousand pounds of freight on each car.

“Freight came from New York by steam boat to South Amboy. I drove the first car, John Twine drove the second car and Edmund Page the third one. We came to the Sand

Hills (near Bordentown) by railroad, there loaded the goods on wagons (it was winter, and the river was frozen over), arriving in Philadelphia by sunrise next morning. The goods left New York at 12 o'clock, noon. This was done by the old firm of Hill, Fish & Abbe."

Immediately after the road from Bordentown to South Amboy was completed, and as late as the summer of 1833, passengers were brought from Philadelphia to the wharf at White Hill by steamboat, and from there were rapidly driven to Amboy. Two horses were hitched to each car, and as they were driven continuously on the run, three changes of horses were required, the finest horses obtainable being purchased for this purpose. The time consumed in crossing the State (thirty-four miles) was from two and a half to three hours.

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Early in September, 1833, the locomotive "John Bull" was put on the train leaving Bordentown about 7 o'clock in the morning, and returning leaving South Amboy at 4 P.M. This was the first passenger train regularly run by steam on the route between New York and Philadelphia.

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THE BRITISH CRUISER AEOLUS.

The new twin screw cruiser AEolus was launched from the Devonport Dockyard on the 13th November. The first keel plate of the AEolus was laid in position on the 10th March last year, and up to the present time fully two thirds of the estimated weight has been worked into her structure. Says *Industries*: She is built of steel, with large phosphor bronze castings for stern post, shaft brackets, and stem, the latter terminating in a formidable ram. The hull is sheathed with wood, and will be covered with copper to enable her to keep the seas for a lengthened period on remote stations, where there is a lack of docking accommodation. All the vital portions, such as machinery, boilers, magazines, and steering gear, are protected by a steel deck running fore and aft, terminating forward in the ram, of which it virtually forms a part. Subdivision has been made a special feature in this type of vessel, and the hull under the upper deck is divided into nearly 100 water tight compartments. Between perpendiculars the AEolus measures 300 ft. in length, the extreme breadth being 43 ft. 8 in., and moulded depth 22 ft. 9 in., with a displacement of 3,600 tons on a mean draught of water of 17 ft. 6 in. She will be supplied by Messrs. Hawthorn, Leslie & Co., of Newcastle on Tyne, with two sets of vertical triple-expansion engines, capable of developing collectively 9,000 h.p., which is estimated to realize a speed of 19.75 knots. As vertical engines have been adopted, the necessary protection of the cylinders, which project above the steel protective deck, is obtained by fitting an armored breastwork of steel 5 in. thick, supported by a 7 in. teak backing, around the engine hatchway. Provision is made for a bunker coal capacity of 400 tons, and this is calculated to give a radius of action of 8,000 knots at a reduced speed of 10 knots. The armament of the ship will consist of two 6 in. breech-loading guns on central pivot stands, one mounted on the poop and another on the forecastle; six quick-firing 4.7 in. guns, mounted three on each broadside; eight quick-firing 6-pounder guns, four on each broadside; besides one 3-pounder Hotchkiss and four 5-barrel Nordenfeldt guns. In addition four torpedo tubes are fitted, one forward, one aft, and one on each broadside. All the necessary appliances for manipulating the engines, guns, steering gear, etc., when in action, are placed in a conning tower built of steel 3 in. thick, and situated at the after end of the forecastle. The AEolus will be rigged with two pole mast, carrying light fore and aft sails only. Her total cost

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is estimated at L188,350, of which L100,000 is regarded as the cost of hull. When complete she will be manned by a complement of 254 officers and men. In the slipway vacated by the AEolus a second class cruiser, to be named the Hermione, will be laid down forthwith. The Hermione may be regarded as an enlarged AEolus, and will measure 320 ft. in length, 49 ft. 6 in. in breadth, with a displacement of 4,360 tons, on a mean draught of water of 19 ft. The new cruiser will be supplied with propelling machinery of the same power as the AEolus, to be constructed in the dockyard from Admiralty designs. The coal capacity of the Hermione is to be 400 tons, and her estimated speed is 19.5 knots.

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TRIALS OF H.M. CRUISER BLAKE.

Special interest, says *Engineering*, attaches to the trials of the protected cruiser Blake, in view of the assertion frequently made by Admiralty authorities, from the first lord downward, to the effect that with her sister ship Blenheim she would surpass anything hitherto attempted. The condition of steaming continuously for long periods and over great distances at 20 knots per hour was made a ruling condition in the design, and with forced draught she was to be able to attain 22 knots when occasion required. But all idea of getting these high results has been abandoned. Our readers do not need to be reminded of the frequent failure of boilers in the navy. Although in the newer ships, profit has been gained by experience, larger boilers being provided with separate combustion chambers for each furnace; the Blake's boilers belong to the type of defective design, with the result that, were they pressed under forced draught, the tubes would leak. It was, therefore, decided some time ago to be content with natural draught results, and on Wednesday, Nov. 18, the vessel was taken out from Portsmouth, and ran for seven hours with satisfactory results, considerably exceeding the contract power. But the speed was but 19.12 knots, and 22 knots can never be attained, except, of course, new boilers be provided, and when an expenditure of 5 or 6 per cent. of the first cost of the vessel (433,755_l.) would give her new boilers, it seems a pity to be content with the lesser speed, more particularly as the vessel is well designed and the engines efficient.

[Illustration: THE NEW BRITISH CRUISER BLAKE.]

Before dealing with the engines and their trials, it may be stated that the vessel is of 9000 tons displacement at 25 ft. 9 in. mean draught. Her length is 375 ft. and her beam 65 ft. She was built at Chatham, and the armament consists of two 92 in. 22-ton breech-loading guns, ten 6-in. 5-ton guns and sixteen 3-pounder quick-firing, and eight machine guns, with torpedo launching carriages and tubes. The propelling engines

were manufactured by Messrs. Maudslay Sons & Field, Lambeth. They were designed to develop 13,000 horses with natural,

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and 20,000 with forced draught. They consist of four distinct sets of triple expansion inverted cylinder engines, and occupy with boilers, *etc.*, nearly two-thirds of the length of the ship. They are placed in four separate compartments, two sets being coupled together on the starboard and port sides respectively for driving each screw. There are four high pressure cylinders, 36 in. in diameter; four intermediate cylinders, 52 in.; and four low pressure cylinders, 80 in.; with a stroke of 4 ft. Each set of engines has an air pump 33 in. in diameter and 2 ft. stroke, and a surface condenser having 12,800 tubes and an aggregate surface of 2250 square feet, the length of the tubes between the tube plates being 9 ft. There is also in each compartment one centrifugal circulating pump driven by a small independent engine, of the diameter of 3 ft. 9 in., and capable of pumping from the bilge as well as the sea. The screw propellers are 18 ft. 3 in. in diameter with a mean pitch of 24 ft. 6 in.

Steam is furnished by six main double-ended boilers, having four furnaces at each end, and one auxiliary boiler, with a heating surface of 900 sq. ft., the dimensions of the former being 15 ft. 2 in. by 18 ft., and of the latter 10 ft. by 9 ft. long. The total area of firegrate surface is 863 sq. ft. and of heating surface 26,936 sq. ft. Each engine room is kept cool by four 4 ft. 6 in. fans. Forced draught is produced by twelve 5 ft. 6 in. fans, three being stationed in each stokehold. The electric lighting machinery consists of three dynamos of Siemens manufacture driven by a Willans engine, each of which is capable of producing a current of 400 amperes. The after main engines can be easily disconnected and worked separately for slow speeds.

The Blake had her steering gear tested on Tuesday, Nov. 17. With both engines going full power ahead and turning to starboard, with her helm hard over 35 deg., she completed the circle in 4 min. 40 sec., the port circle being completed in 5 min. 5 sec. The diameter was estimated approximately to be about 575 yards. Forty-five seconds were required to change from engine steering to steering by hand. By manual gear the helm was moved from midships to hard a-starboard in 40 sec., from starboard to hard a-port in 2 min. 10 sec., and from hard a-port to midships in 2 min. 20 sec. The heavy balanced rudder and the speed of the ship throwing great labor upon the crew manning the wheels, the hand gear was afterward disconnected and the connection with the steering engine completed in 40 sec.

[Illustration: THE NEW BRITISH CRUISER BLAKE]

On Nov. 18, when the vessel went on speed trials, the draught of the vessel was 24 ft. 8 in. forward and 26 ft. 8 in. aft, which gave her the mean load immersion provided for in her design. There was a singular absence of vibration, said to be due to the space over which the machinery is spread, but perhaps also due, in part at least, to the number of cranks, as the cylinders deliver six throws throughout the circle of revolution. The results of each hour's steaming are as under:

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Hours.	Revolutions.	Steam.	Power.
1st hour	86.86	120.6	13,568
2d "	89.26	128.0	15,298
3d "	88.55	125.0	14,251
4th "	89.58	127.6	14,759
5th "	89.40	125.0	14,394
6th "	89.55	125.0	14,512
7th "	89.15	126.0	14,893

The trial was originally intended to continue for eight hours, but at the end of the seventh, as the light began to fade, and as, moreover, the engines were working with a smoothness and efficiency that showed no signs of flagging, it was considered expedient to terminate the run.

Steam pressure in boilers	125.5 lb.
Air pressure in stoke holds	0.42 in.
Revolutions per minute, starboard	88.41
Revolutions per minute, port	89.39

	Starboard.	Port.	
	+	+	+
	Forward	Aft	Forward
Vacuum in condensers.	27.85	27.85	28.1
Mean pressure in cylinders, high	43.04	38.95	42.36
Mean pressure in cylinders, inter.	31.49	30.82	30.17
Mean pressure in cylinders, low	11.68	12.4	12.85
Indicated horse power each engine	3631.42	3589.07	3721.37
Total	7220.39	7304.88	
Collectively	14525.37		

As will be seen, the collective power exceeds the contract power under natural draught by 1,525.37 horses, and was obtained with less than the Admiralty limit of air pressure. The coal used on the occasion was Harris' deep navigation, but no account was taken of the amount consumed. Four runs were made on the measured mile with and against the tide, the mean of means disclosing a speed of 19.12 knots. The average speed of the seven hours' steaming, as measured by patent log, was 19.28 knots. This fell short by over three-quarters of a knot of what was anticipated in proportion to the power indicated by the engines. Up to the limit of air pressure used the boilers answered admirably.

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HINTS TO SHIPMASTERS.

A Master in charge of a tramp steamer in these days *must*, if he wishes for any comfort in life, take good care of himself, for the pressure and hurry which is inseparable from his position, combined with the responsibilities and anxieties of his calling, put a very great strain upon him, and will, in time, unless he takes special care, have a serious effect on his health; this is more particularly the case with men of the nervous temperament. It cannot be expected that in this age, when so many thousands of people on shore fail from overwork and "high pressure," steamship masters, who as a class, are overworked and harrassed to a serious extent, should altogether escape. Again, unless a shipmaster takes an interest in the health, comfort, and well-being of his crew, he, in the first place, neglects one of his duties, and, secondly, sows the seeds of discomfort and annoyance to himself. Let us consider his duties to himself personally.

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First, then, he must prepare himself to undergo, periodically, the discomfort of want of proper rest and irregularity in times of meals; he may, for instance, not be able to leave the bridge for over forty-eight hours or more on a stretch, and, of course, any shipmaster who may read this will know that this is no uncommon occurrence; during this time he may be unable to get regular meals, and what he does get may have to be eaten in a hurry and at an anxious time when he cannot properly enjoy and digest it.

A time like this may be followed by a period of rest, when the days will hang heavily on his hands, and he will be tempted to long afternoon sleeps merely to get through the weary hours.

Now, as a course of this kind of thing is bound, unless care be exercised, to act unfavorably on the digestion and bring on some form of dyspepsia, so also the nights and days of great anxiety and moments of great strain will, besides increasing the dyspeptic tendency, be apt to bring on nervousness in some form or other. It is a fact that in these times, and often from want of attention to health, nearly every shipmaster long in harness is more or less nervous.

There are people in the present day who have actually talked of making their chief engineer (who exercises his special trade at sea or on shore as suits himself and is in no sense a *seaman*) the master of the vessel, and turning the shipmaster into a mere pilot. Those who talk in this way forget that to do this the *responsibility* must be shifted on to the engineer. Of course such a change as this cannot happen, the country would not stand it; but I merely mention it to show the vast amount of ignorance there is, even among those who should be well informed, as to the real strain and responsibility on the modern shipmaster.

The master then, if anxious to do the best for himself, should, if possible, be a total abstainer, for two reasons: first, because, as he will be obliged to be irregular in his feeding, alcohol in any form will do him harm and tend to augment the dyspepsia. Secondly, because, often in times of great mental strain, combined with exposure, a glass of spirits will give *great temporary relief* (which is of itself a dangerous fact for a weak-minded man), but this will always be followed by depression, and will in reality be doing great harm instead of lasting good. Spirituous liquor may be necessary for a few, but these should use it under medical advice if at all. It is a hard thing for many men to give up their grog, but there is not a man of any experience in the merchant service who has not seen its blasting effects on many a master and officer. It is almost impossible to find a substitute for it which shall recommend itself to anyone who has really a liking for it, about the only things being coffee, lime juice, or lemonade and ginger ale. So-called temperance drinks are all of them very nasty stuff, besides containing a large percentage of alcohol;

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rather than swallow these one had better not change his habits. The master then, being an abstainer, should also give some care to his diet. Very heavy meals of meat and strong food should not be taken at sea, because there are no means of taking proper exercise, and it is impossible to work them off properly. Again, long, heavy, after-dinner sleeps should not be indulged in; a quiet nap of ten minutes would in many cases be beneficial, but the long sleep up to five o'clock is positively harmful to any man. One of the *best* things a master can do is to take up some work. No matter what it is so long as he takes an interest in it, such as joiner work, fret work, painting, writing, learning a musical instrument or a foreign language, or anything of that sort. It will be of incalculable benefit to both mind and body.

On occasions when it is absolutely necessary to be on deck for long periods, the steward ought to have orders to attend *himself personally* to the master's wants—to see that his meals are properly cooked and brought up to him at regular intervals, and that there is always a *well made* cup of coffee to be had when wanted. The ordinary cup of coffee as made at sea is generally a beastly mixture and not worth drinking. The steward has an easy life and should not be spared at these times, but should always be turned out when wanted, *night or day*, and made to look after these things himself, and a man who growls at having this to do or who will not take the proper trouble to see things well cooked and served up nicely with cheerfulness should *at once* be discharged, and a good man, of whom there are plenty, shipped in his place. The master, of course, should always be on the bridge when required, and in fog certainly all the time; but many men are over-cautious in this respect through sheer nervousness, and oftentimes expose and fatigue themselves to no purpose, harass their officers, and make them unreliable, so that when the time comes that their presence on deck is absolutely necessary, they are, through exhaustion of mind and body, in anything but a fit state to take charge of the ship, or be cool and collected in a moment of sudden emergency. Should a man feel that through hard work and exposure he is becoming shaky, he should at once leave off *entirely* the false relief which drink gives and consult a physician. A *good* man with *experience* will in almost any case be able to help him, and, besides medicine, give him such hints for regulating his diet and mode of living as will enable him to bear better than before the strain and wear and tear of his life.[1]

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[Footnote 1: For the *fluttering*, unsteady feeling often felt, the following, if not abused, will be found beneficial: Take as much bromide of potassium as will lie, not heaped up, on a shilling, and half a teaspoonful of sal volatile (aromatic spirits of ammonia). Mix in a wine glass full of water; but this should only be taken when absolutely necessary, and not habitually.]

As to the crew. A master who has full command of himself ought to be able to rule judiciously even the most unruly crew, but before he is in a really *strong* position to do this, he must treat them fairly and honestly. In many cases a bad start is made with a new set of men (of course this will not apply to the high class mail steamers, nor perhaps to what are termed weekly boats). They come on board and find their fore-castle just as the last crew left it, full of a week's filth,[2] possibly lumbered up with hauling lines and what-not, wanting painting badly, and often showing unmistakable signs of overhead leakage. This is quite enough to make a respectable man discontented, and naturally so. In common fairness, the often wretched place that the men have to occupy ought to be put in decent order to receive the new crew. Again, they should be distinctly made to understand, when signing articles, what their *food* will be, and what their pay and allowances will come to. It is to be feared that bad feeding is the cause of much trouble in these days. From first coming on board discipline should be *enforced*; many officers, both young and old, are greatly remiss in enforcing this, with the consequence that day by day it is harder to do, till at last it is impossible, and anarchy reigns triumphant. If a seaman finds that he is *fairly* treated, and that he *must* obey orders, he will in nine cases out of ten conduct himself well, and give no trouble. The more high class type of man the master is the better he will treat his men, and the more exacting he will be in compelling discipline, both in his officers and crew.

[Footnote 2: This should not be. It is most decidedly one of the master's duties to see that the men on *both* sides of the fore-castle keep their places clean, and for this purpose it is a very good plan to give them an hour or two every week, and it is only right that if a crew fled a fore-castle clean to receive them, they should be made to leave it in the same state.]

Engineers and firemen are often sources of annoyance in these days. Firemen are a lower class generally than seamen, and more inclined to insubordination; in many cases the engineers are quite incapable of keeping them in proper order, and it sometimes happens that in an engine room row it falls to the lot of the deck officers to restore discipline.

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The master should remember that his engineers are officers of the ship, with their own responsibility, that his chief engineer is of some importance on board, and that it is necessary in the owner's interests that they should work together amicably. In ordinary cargo vessels, the engineer is often better educated than the master himself, and should *never* be treated as an inferior while he behaves with proper respect to the master. To his own deck officers the master should behave with ordinary courtesy, and, if he finds them trustworthy, should not spoil them and render them unreliable by always keeping on or about the bridge; an officer who is never left by himself in charge will soon fancy himself incapable. It is to be feared that many young officers are spoiled in this way.

Familiarity with the men before the mast is always unwise. It is not a good practice in ordinary vessels, where a new crew is shipped each voyage, to begin by calling the men "Tom" and "Jack." An officer to have any real command over the men *must* keep himself apart from them and show them the difference of their positions. A judicious shipmaster will warn his young mates about this.

The usual system of mess room for engineers, the officers messing in the cabin with the master, is a good one, though it is a question whether it would not be a *very* good thing if the chief engineer always messed with the master so long as he was a decent, respectable man. It is often one of the causes of ill health in the master that he keeps too much to himself, seldom if ever speaking to his officers except on business connected with the ship. A man who does this has far too much time to think, and if he has any trivial illness is apt to brood over it and actually make himself ill.

It is much wiser and better for all concerned that the master should, within certain limits, be on friendly terms at any rate with his first mate, if not with all his officers. Any man with common tact can always find means for checking undue familiarity, and it will generally be found that officers treated as equals instead, as is often the case, as though they were an inferior race of beings, will be much more inclined to do their work with zeal, and to back up the master in all his troubles. Many men when they get command seem to forget that they ever were officers themselves. It is the general opinion that the strict ship is the most comfortable one, and as a rule the master who will take the trouble to enforce proper discipline fore and aft is just the very man who will also be considerate and courteous to those who sail under his command—whatever be their rank.

To govern others well a man *must* first have learned to govern himself. The first lesson for a young seaman to learn is obedience, and unless he does learn this lesson he will not know how to enforce it when he becomes an officer, and still less will he be fit for his position when he obtains command. It is to be feared that many *never* learn this lesson, and that this is the cause of much of the insubordination rife in these days.

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If the modern hard-driven shipmaster would exercise greater care as to his health and habits, and would strive more after being a true *master* over his ship's company, and this is easier to be gained by respect than fear, things would go on more smoothly, and when he did get away for a time from all the petty annoyances of shore, which are more especially felt in his home port, he would have a time of comparative comfort, would live longer and happier, and, possibly, escape the terrible attacks of nervous depression which have finished the career of many a too finely strung *fin de siecle* shipmaster. — *Nautical Magazine*.

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ALFRED TENNYSON.

Alfred Tennyson, the poet laureate of England, was born at Somersby, Lincolnshire, April 9, 1810, and was the third of a large family of children, eight of whom were boys and three girls. His father was a clergyman, a man of remarkably fine abilities; his mother, as should be the mother of a great poet, was a deeply religious woman with a sensitive spirit that was keenly attuned to the aspects of nature. It was from her that Tennyson inherited his poetic temperament combined with the love of study that was a characteristic of his father. Tennyson's brother, Charles, superintended the construction of his younger brother's first poetic composition, which was written upon a slate when the great laureate was a child of seven. Tennyson's parents were people who had sufficient of this world's wealth to educate their sons well, and Alfred was sent to Trinity College, where he as a mere lad won the gold medal for a poem in blank verse entitled "Timbuctoo," which is to be found in all the volumes of his collected works, though many of the other poems produced in that period are not given place.

[Illustration: ALFRED TENNYSON, POET LAUREATE OF ENGLAND.]

His first volume of poems was published in 1827, and in them the influence of Byron, whom he passionately admired, is everywhere visible. In 1830 he issued another volume, which defined his position as a poet of great promise, but which was criticised by Christopher North with the most biting sarcasm, and which was held up to ridicule by the great Lockhart. More than ten years followed in which the poet wrote nothing, then he began a literary career which lifted him to the highest place in the literary world, a place which he has since held, and as a lyric poet he has never been equaled.

In 1850 he issued that most wonderful production in any language, "In Memoriam," which has enriched the English language by hundreds of quotations and which in its delicate sentiment, its deep sorrow, its reflective tenderness, has been the voice of many a soul similarly bereft.

Had Tennyson never written anything but “In Memoriam,” his fame would have been assured, but “The Idylls of the King,” “Enoch Arden,” “The Princess,” and other great compositions will stand forever to his credit. Of Tennyson’s personal character much has been said and written. As pure and sweet as his poetry, beloved by a large circle of friends, active still in literary work, it may be said of him that he has always worn

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“without reproach
The grand old name of gentleman,”

and that his mellow old age is the ripening into fruit of “the white flower of a blameless life.”—*Chicago Graphic*.

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FIFTIETH YEAR OF THE PRINCE OF WALES.

In the case of a distinguished person whose public life has a claim to be regarded with national and social interest, his fiftieth birthday must be considered a jubilee; and Monday, Nov. 9, in the present year, completing that number of anniversaries for the eldest son of her Majesty the Queen, the heir apparent to the crown of the United Kingdom, is manifestly an occasion demanding such congratulations as must arise from sentiments of loyalty to the monarchical constitution and of respect for the reigning family. His Royal Highness, it is understood, has preferred to have it treated simply as a private and domestic affair, entertaining a party of his personal friends, and not inviting any formal addresses from the representatives of municipal corporations or other public bodies. Nevertheless, it may be permitted to journalists, taking note of this period in the life of so important a contemporary personage, to express their continued good wishes for his health and happiness, and to indulge in a few retrospective observations on his past career.

Born on Nov. 9, 1841, second of the offspring of Queen Victoria by her marriage with the late Prince Consort, Albert Edward, Prince of Wales, inherited the greatest blessing of humanity, that of having good parents and wise guardians of his childhood and youth. His instruction at home was, no doubt, wider in range of studies than that of ordinary English boys, including an acquaintance with several European languages and with modern history, needful to qualify him for the duties of a prince. He was further educated at Christ Church, Oxford, and at Trinity College, Cambridge; was enrolled a law student of the Middle Temple and held a commission in the army.

His earliest appearance in a leading part on any public occasion was in 1858 or 1859, we think at the laying of the foundation stone of the Lambeth School of Art at Vauxhall; but after the lamented death of his father, in December, 1861, the Prince of Wales naturally became the most eminent and desirable performer of all ceremonies in which beneficent or useful undertakings were to be recognized by royal approval. This work has occupied a very large share of his time during thirty years; and we can all testify that it has been discharged with such frank good will, cordiality, and unaffected graciousness, with such patient attention, diligence, and punctuality, as to deserve the gratitude of large numbers of her Majesty's subjects in almost every part of the

kingdom. No prince of any country in any age has ever personally exerted himself more constantly and faithfully, in rendering services of

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this kind to the community, than the Prince of Wales. The multiplicity and variety of his engagements, on behalf of local and special objects of utility, would make a surprising list, and they must have involved a sacrifice of ease and leisure, and endurance of self-imposed restraint, a submission to tedious repetitions of similar acts and scenes, and to continual requests and importunities, which few men of high rank would like to undergo.

[Illustration: THE PRINCE OF WALES AND FAMILY—FROM THE PHOTOGRAPH OF MESSRS. BYRNE, RICHMOND.]

The marriage of his Royal Highness to Princess Alexandra of Denmark, on March 10, 1863, was one of the happiest events within the memory of this generation. It tended visibly, of course, to raise and confirm his position as leader of English society, and as the active dispenser of that encouragement which royalty can bestow on commendable public objects. Charity, education, science, art, music, industry, agriculture, and local improvements are in no small measure advanced by this patronage. The Prince of Wales may not be so learned in some of these matters as his accomplished father, but he has taken as much trouble to assist the endless labors of the immediate agents, in doing which he has shown good judgment and discretion, and a considerable degree of business talent—notably, in the British preparations for the Paris Exhibition of 1867, the Indian and Colonial Exhibition of 1886 in London, and the organization of the Imperial Institute. The last-named institution and the Royal College of Music will be permanent memorials of the directing energy of the Prince of Wales.

These are but a few examples or slight indications of the work he has actually done for us all. It is unnecessary to mention the incidental salutary influences of his visits to Canada and to India, which have left an abiding favorable impression of English royalty in those provinces of the empire. Nor can it be requisite to observe the manner in which the prince's country estate and mansion at Sandringham, with his care of agricultural improvement, of stock breeding, studs, and other rural concerns, has set an example to landowners, the value of which is already felt. We refrain upon this occasion from speaking of the Princess of Wales, or of the sons and daughters, whose lives, we trust, will be always good and happy. It is on the personal merits and services of the head of their illustrious house, with reference only to public interests, that we have thought it needful to dwell, in view of the fiftieth birthday of his Royal Highness; and very heartily to wish him, in homely English phrase, "Many happy returns of the day!"—*Illustrated London News*.

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DEVELOPMENT WITH SUCRATE OF LIME.

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I have experimented with carbonate of lithia as an accelerator, and I have obtained with it rather favorable results. However, in opposition to Mr. Wickers, I have always found that carbonate of lithia, used even in larger doses than those recommended by this author, was not sufficiently active, and that development had to be too much prolonged in order to obtain prints of good intensity. I have also observed that the prints developed by this process were as often fogged as when I made use of carbonate of potash. The oxides of alkaline metals or their alkaline salts are not the only accelerators susceptible of being used in pyro development. Two oxides of the earthy alkaline metals, lime and hydrate of barytes, may also be used as accelerators. I will not insist upon the second, which, although giving some results, should be rejected from photographic practice on account of its caustic properties, and of its too great affinity for the carbonic acids in the air, which prevents the keeping of its solutions. This objection does not obtain for the first, provided, however, that ordinary lime water is not used, but a solution of succharate or sucrate of lime. In my experiments I have made use of the following solutions:

Solution A.

Pyrogallic acid. 10 grms.
Sulphite of soda. 20 "
Citric acid. 2 "
Water. 120 "

Solution B.

Water. 1000 "
Sugar. sufficient quantity to triturate.

To which add a sufficient quantity of pure lime to saturate the sugar solution.

In this manner we get a highly concentrated liquid, very alkaline, and which keeps for a considerable time. To develop, I mix:

Water. 80 cubic cent.
Solution A. 2 " "

I throw this over the plate, and allow it to remain for a few moments, agitating, then I add to this bath gradually and according to the results obtained, from one to two cubic centimeters of the solution B. These solutions should be made with a great deal of care and prudence, as the sucrate of lime is an accelerator of very great energy. Moreover, according as the plate has been more or less exposed, we may add to the developing bath a few drops of a solution of citric acid, or of a solution of an alkaline bromide. We obtain in this way very soft prints, sometimes too soft, which, however, are not more free from fogging than plates developed with hydrochinon (new bath), or pyro having for



accelerators ammonia, potash, soda, carbonate of potash, of soda, or of lithia. I do not give this process with sucrate of lime as perfect, but I give it as perfectable and susceptible of application. If I have undertaken to write these few lines it is because it has never been brought to my knowledge that up to the present time the oxides and the alkaline salts of the earthy alkaline metals have been studied from a photographic point of view.—*Leon Degoix in Photo. Gazette.*

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DUCK HUNTING IN SCOTLAND.

The wild duck is a shy bird, apt to spread his wings and change his quarters when a noble sportsman is seen approaching his habitation with a fowling piece. You have heard of the ass who put on a lion's skin, and wandered out into the wilderness and brayed. I have elaborated a device of equal ingenuity and more convincing realism. It is my habit during the duck-shooting season to put on the skin of a Blondin donkey and so roam among the sedges bordering on the lakes where wild ducks most do congregate. I have cut a hole in the face to see through, and other holes in the legs to put my hands through.—*London Graphic*

[Illustration: WILDFOWL SHOOTING IN SCOTLAND.]

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A PLEA FOR THE COMMON TELESCOPE.[1]

By G.E. LUMSDEN.

[Footnote 1: Paper read before the Astronomical and Physical Society of Toronto, Canada, April 18, 1891.]

These are the palmiest days in the eventful history of physical and observational astronomy. Along the whole line of professional and amateur observation substantial progress is being made, but in certain new directions, and in some old ones, too, the advance is very rapid. As never before, public interest is alive to the attractions and value of the work of astronomers. The science itself now appeals to a constituency of students and readers daily increasing in numbers and importance. Evidence of this gratifying fact is easily obtained. There is at the libraries an ever-growing demand for standard astronomical works, some of them by no means intended to be of a purely popular character. Some of the most influential and conservative magazines on both sides of the Atlantic now find it to be in their interest to devote pages of space to the careful discussion of new theories, or to the results of the latest work of professional observers. Even the daily press in some cities has caught the infection, if infection it may be called. There are in New York, Philadelphia, St. Louis, and other centers of population on this continent leading newspapers which, every week or so, publish columns of original matter contributed by writers evidently able to place before their readers in an attractive form articles dealing accurately, and yet in a popular vein, with the many-sided subject of astronomy. In scientific matters generally, there is abroad in this and other countries a spirit of inquiry, never more apparent than at the present time.

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Readers and thinkers may, no doubt, be numbered by thousands. So far, however, as astronomy is concerned, the majority of readers and thinkers is composed of non-observers, most of whom believe they must be content with studying the theoretical side of the subject only. They labor under the false impression that unless they have telescopes of large aperture and other costly apparatus, the pleasures attaching to practical work are denied them. The great observatories, to which every intelligent eye is directed, are, in a measure, though innocently enough, responsible for this. Anticipation is ever on tiptoe. People are naturally awaiting the latest news from the giant refracting and reflecting telescopes of the day. Under these circumstances, it may be that the services rendered, and capable of being rendered, to science by smaller apertures may be overlooked, and, therefore, I ask to be permitted to put in a modest plea for the common telescope. What little I shall have to say will be addressed to you more for the purpose of arousing interest in the subject than for communicating to you any information of a novel or special character.

When making use of the term "common telescope," I would like to be understood as referring to good refractors with object glasses not exceeding three or three and one-half inches in diameter. In some works on the subject telescopes as large as five inches or even five and one-half inches are included in the description "common," but instruments of such apertures are not so frequently met with in this country as to justify the classing of them with smaller ones, and, perhaps, for my purpose, it is well that such is the fact, for the expense connected with the purchase of first rate telescopes increases very rapidly in proportion to the size of the object glass, and soon becomes a serious matter. Should ever the larger apertures become numerous on this continent, let us hope it shall be found to have been as one of the results of societies like this, striving to make more popular the study of astronomy.

It is not by any means proposed to inflict upon you a history of the telescope, but your indulgence is asked for a few moments while reference is made to one or two matters connected with its invention, or, rather, its accidental discovery and subsequent improvement.

The opening years of the seventeenth century found the world without a telescope, or, at least, such an instrument as was adapted for astronomical work. It is true that long years before, Arabian and some other eastern astronomers, for the purpose, possibly, of enabling them to concentrate their gaze upon celestial objects and follow their motions, had been accustomed to use a kind of tube consisting of a long cylinder without glasses of any kind and open at both ends. For magnifying purposes, this tube was of no value. Still, it must have been of some kind of service, or else the first telescopes, as constructed by the spectacle makers, who had stumbled upon the principle involved, were exceedingly sorry affairs, for, soon after their introduction, the illustrious Kepler, in his work on "Optics," recommended the employment of plain apertures, without lenses, because they were superior to the telescope on account of their freedom from refraction.

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But as soon as the principle by which distant objects could, apparently, be brought nearer the eye became known and its value recognized by philosophers, telescopes ceased to be regarded as toys, and underwent material improvements in the hands of such men as Galilei, and, later, even of Kepler himself, Cassini, Huyghens, and others. Galilei's first telescope magnified but three times, and his best not much above thirty times. If I comprehend aright what has been written upon the subject, I am justified in saying that this little instrument in my hand, with an aperture of one inch and one-quarter, and a focus, with an astronomical eye-piece, of about ten inches, is a better magnifier than was Galilei's best. With it I can see the moons of Jupiter, some spots on the sun, the phases of Venus, the composition, in some places, of the Milky Way, the seas, the valleys, the mountains, and, when in bold relief upon the terminator, even some of the craters and cones of the moon. Indeed, I am of opinion I can see even more than he could, for I can readily make out a considerable portion of the Great Nebula in Orion, some double stars, and enough of the Saturnian system to discern the disk of the planet and see that there is something attached to its sides.

For nearly one hundred and fifty years all refracting telescopes labored under one serious difficulty. The images formed by them were more or less confused by rainbow tints, due to the bending, or refracting, by the object glass of the rays of light. To overcome this obstacle to clear vision, and also to secure magnification, the focal lengths of the instruments were greatly extended. Telescopes 38, 50, 78, 130, 160, 210, 400, and even 600 feet long were constructed. I can, however, find nothing on record indicating that the object glasses of these enormously attenuated instruments ever exceeded in diameter two and one-half inches. Yet, with unwieldy and ungainly telescopes, nearly always defining badly, wonders were accomplished by the painstaking and indomitable observers of the time.

In 1658, Huyghens, using a telescope twenty-three feet long and two and one-third inches in diameter, with a power of 100, solved the mystery of Saturn's rings, which had resisted all of Galilei's efforts as well as his own with a shorter instrument, though he had discovered Titan, Saturn's largest moon, and fixed correctly its period of revolution at sixteen days. Fifteen years later, Ball, with a telescope thirty-eight feet long, discovered the principal division in the rings. Ten years still later, Cassini, with an instrument twenty feet long and an object glass two and one-half inches in diameter, rediscovered the division, which was named after him, rather than after Ball, who had taken no pains to make widely known his discovery, which, in the meantime, had been forgotten. Though we have no record, there is no doubt that the lamented Horrocks and Crabtree, in England, in 1639, with glasses no better than these, watched with exultant emotions the first transit of Venus ever seen by human eyes.

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In 1722, Bradley, with a telescope 223 1/4 feet long, succeeded in measuring the diameter of the same planet. Yet Grant assures us that, in spite of all their difficulties, such was the industry of the astronomers that when, at the commencement of this century, it became possible to construct larger refracting telescopes, there was nothing to be discovered that could have been discovered with the means at their disposal. So far as we now know, a good three-inch telescope, nay, a first-rate two inch one, will show far more than our great-grandfathers ever saw, or dreamed of seeing, with their refractors.

Toward the middle of the seventeenth century the reflecting telescope had been so much improved as nearly to crowd out its refracting rival, but, just as its success seemed to be assured, Dollond, working along lines partially followed up by Hall, found a combination of lenses by which the chromatic aberration of the refractor could be very perfectly corrected. While Dollond's invention was of immense value, it remained that flint object glasses larger than two and one-half inches in diameter could not, for some years, be manufactured, but about the opening of the nineteenth century, Guinand, a Swiss, discovered a process of making masses of optical flint glass sufficiently large as to admit of the construction from them of excellent lenses of sizes gradually increasing as time and experimenting went on. The making of three-inch objectives, achromatic and of short focus, wrought a revolution in telescopes and renewed the demand for refractors, though prices, as compared with those of the present day, were very great. But improvement was succeeded by improvement. Larger and still larger objectives were made, yet progress was not so rapid as not to justify Grant, in 1852, in declaring to be a "munificent gift" the presentation, about 1838, to Greenwich Observatory, of a six and seven-tenths object glass alone, and so it was esteemed by Mr. Airy, the astronomer royal. Improvement is still the order of the day, and, as a result of keen competition, very excellent telescopes of small aperture can be purchased at reasonable prices. Great telescopes are enormously expensive, and will probably be so until they are superseded by some simple invention which shall be as superior to them as they are to the "mighty" instruments which, from time to time, caused such sensations in the days of Galilei, Cassini, Huyghens, Bradley, Dollond, and those who came after them.

But, notable as are the services rendered to science by giant telescopes, it remains that by far the greater bulk of useful work has been done by apertures of less than twelve inches in diameter. Indeed, it may be asserted that most of such work has been done by instruments of six inches or less in size. After referring with some detail to this, Denning tells us that "nearly all the comets, planetoids, double stars, *etc.*, owe their detection to small instruments; that our knowledge of sun spots, lunar

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and planetary features is also very largely derived from similar sources; that there is no department which is not indebted to the services of small telescopes, and that of some thousands of drawings of celestial objects, made by observers employing instruments from three to seventy-two inches in diameter, a careful inspection shows that the smaller instruments have not been outdone in this interesting field of observation, owing to their excellent defining powers and the facility with which they are used." Aperture for aperture, the record is more glorious for the "common telescope" than for its great rivals. Let us for a moment recall something of what has been done with instruments which may be embraced under the designation "common" as such a statement may serve to remove impressions that small telescopes are but of little use in astronomical work.

In his unrivaled book, Webb declares that his observations were chiefly made with a telescope five and one-half feet long, carrying an object glass of a diameter of three and seven-tenths inches. The instrument was of "fair defining quality," and one has but to read his delightful pages in order to form an idea of the countless pleasures Webb derived from observation with it. Speaking of it, he says that smaller ones will, of course, do less, especially with faint objects, but are often very perfect and distinct, and that even diminutive glasses, if good, will, at least, show something never seen without them. He adds: "I have a little hand telescope twenty-two and one-quarter inches long, when fully drawn out, with a focus of about fourteen inches, and one and one-third inches aperture; this, with an astronomical eye-piece, will show the *existence* of sun spots, the mountains in the moon, Jupiter's satellites and Saturn's ring." In another place, speaking of the sun, he says that an object glass of only two inches will exhibit a curdled or marbled appearance over the whole solar disk, caused by the intermixture of spaces of different brightness. And I may add here that Dawes recommends a small aperture for sun work, including spectroscopic examinations, he himself, like Mr. Miller, our librarian, preferring to use for that purpose a four inch refractor.

As you know, the North Star is a most beautiful double. Its companion is of the ninth order of magnitude, that is, three magnitudes smaller than the smallest star visible to the naked eye on a dark night. There was a time when Polaris, as a double, was regarded as an excellent test for a good three inch telescope; that is any three inch instrument in which the companion could be seen was pronounced to be first-class. But so persistently have instruments of small aperture been improved that that star is no longer an absolute test for three inch objectives of fine quality, or any first-rate objective exceeding two inches for which Dawes proposed it as a standard of excellence, he having found that if the eye and telescope be good,

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the companion to Polaris may be seen with such an aperture armed with a power of eighty. As a matter of fact, Dawes, who was, like Burnham, blessed with most acute vision, saw the companion with an instrument no larger than this small one in my hand—one inch and three-tenths. Ward saw it with an inch and one-quarter objective, and Dawson with so small an aperture as one inch. T.T. Smith has seen it with a reflector stopped down to one inch and one-quarter, while in the instrument still known as the “great Dorpat reflector,” it has been seen in broad daylight. This historic telescope has, I believe, a twelve inch object glass, but the difficulty of seeing in sunshine so minute a star is such that the fact may fairly be mentioned here.

Another interesting feature is this. Objects once discovered, though thought to be visible in large telescopes only, may often be seen in much smaller ones. The first Herschel said truly that less optical power will show an object than was required for its discovery. The rifts, or canals, in the Great Nebula in Andromeda is a case in point, but two better illustrations may be taken from the planets. Though Saturn was for many years subjected to most careful scrutiny by skilled astronomers using the most powerful telescopes in existence, the crape ring eluded discovery until November, 1850, when it was independently seen by Dawes, in England, and Bond, in the United States. Both were capital observers and employed excellent instruments of large aperture, and it was naturally presumed that only such instruments could show the novel Saturnian feature. Not so. Once brought to the attention of astronomers, Webb saw the new ring with his three and seven-tenths telescope and Ross with an aperture not exceeding three and three-eighths in diameter. Nay, I am permitted to say that a venerable member of this society made drawings of it with a three inch refractor. With a two inch objective, Grover not only saw the crape ring, but Saturn's belts, as well, and the shadow cast by the ball of the planet upon its system of rings. Titan, Saturn's largest moon, is merely a point of light as compared with the planet, as it appears in a telescope, yet it has been seen, so it is said, with a one inch glass. The shadow of this satellite, while crossing the face of Saturn, has been observed by Banks with a two and seven-eighths objective. By hiding the glare of the planet behind an occulting bar, some of Saturn's smallest moons were seen by Kitchener with a two and seven-tenths aperture and by Capron with a two and three-fourths one. Banks saw four of them with a three and seven-eighths telescope, Grover two of them with a three and three-quarter inch, and four inches of aperture will show five of them, so Webb says. Rhea, Dione and Tethys are more minute than Japetus, yet Cassini, with his inferior means, discerned them and traced their periods. Take the instance of Mars next. It was long believed that Mars had no satellites.

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But in 1877, during one of the highly favorable oppositions of that planet which occur but once in about sixteen years, the able Hall, using the great 26 inch refractor at Washington, discovered two tiny moons which had never been seen before. One of these, called Deimos, is only six miles in diameter, the other, named Phobos, is only seven, and both are exceedingly close to the primary and in rapid revolution. The diameter of these satellites is really less than the distance from High Park, on the west of Toronto, to Woodbine race course, on the east of the city. No wonder these minute objects—seldom, if ever, nearer to us than about forty millions of miles—are difficult to see at all. Newcomb and Holden tell us that they are invisible save at the sixteen year periods referred to, when it happens that the earth and Mars, in their respective orbits, approach each other more nearly than at any other time. But once discovered, the rule held good even in the case of the satellites of Mars. Pratt has seen Deimos, the outermost moon, with an eight and one-seventh inch telescope; Erek has seen it with a seven and one-third inch achromatic; Trouvellot, the innermost one, with a six and three-tenths glass, while Common believes that any one who can make out Enceladus, one of Saturn's smallest moons, can see those of Mars by hiding the planet at or near the elongations, and that even our own moonlight does not prevent the observations being made. It chances for the benefit of observers, in the northern hemisphere especially, that one of the sixteen year periods will culminate in 1893, when Mars will be most advantageously situated for close examination. No doubt every one will avail himself of the opportunity, and may we not reasonably hope that scores of amateur observers throughout the United States and Canada will experience the delight of seeing and studying the tiny moons of our ruddy neighbor?

And so I might proceed until I had wearied you with illustrations showing what can be done with telescopes so small that they may fairly be classed as "common," Webb says that such apertures, with somewhat high powers, will reveal stars down to the eleventh magnitude. The interesting celestial objects more conspicuous than stars of that magnitude are sufficiently numerous to exhaust much more time than any amateur can give to observing. Indeed, the lot of the amateur is a happy one. With a good, though small, telescope, he may have for subjects of investigation the sun with his spots, his faculae, his prominences and spectra; the moon, a most superb object in nearly every optical instrument, with her mountains, valleys, seas, craters, cones, and ever-changing aspects renewed every month, her occupations of stars, her eclipses, and all that; the planets, some with phases, and other with markings, belts, rings, and moons with scores of occupations, eclipses and transits due to their easily observed rotation around their primaries; the nebulae, the double, triple and multiple stars with sometimes beautifully contrasted colors, and a thousand and one other means of amusing and instructing himself. Nature has opened in the heavens as interesting a volume as she has opened on the earth, and with but little trouble any one may learn to read in it.

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I trust it has been shown that expensive telescopes are not necessarily required for practical work. My advice to an intending purchaser would be to put into the objective for a refractor, or into the mirror for a reflector, all the money he feels warranted in spending, leaving the mounting to be done in the cheapest possible manner consistent with accuracy of adjustment, because it is in the objective or in the mirror that the *value* of the telescope alone resides. In the shops may be found many telescopes gorgeous in polished tubes and brass mountings which, for effective work, are absolutely worthless. On this subject, I consulted the most eminent of all discoverers of double stars, an observer who, even as an amateur, made a glorious reputation by the work done with a six inch telescope. I refer to Mr. S.W. Burnham, of the Lick Observatory, who, in reply, kindly wrote: "You will certainly have no difficulty in making out a strong case in favor of the use of small telescopes in many departments of important astronomical work. Most of the early telescopic work was done with instruments which would now be considered as inferior to modern instruments, in quality as well as in size. You are doubtless familiar with much of the amateur work, in this country and elsewhere, done with comparatively small apertures. *The most important condition is to have the refractor, whatever its size may be, of the highest optical perfection, and then the rest will depend on the zeal and industry of the observer.*" The italics are mine.

Incidentally, it may be mentioned that much most interesting work may be done even with an opera glass, as a few minutes' systematic observation on any fine night will prove. Newcomb and Holden assure us that "if Hipparchus had had even such an optical instrument, mankind need not have waited two thousand years to know the nature of the Milky Way, nor would it have required a Galilei to discover the phases of Venus or the spots on the sun." To amplify the thought, if that mighty geometer and observer and some of his contemporaries had possessed but the "common telescope," is it not probable that in the science of astronomy the world would have been to-day two thousand years in advance of its present position?

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ARCHAEOLOGICAL DISCOVERIES AT CADIZ.

Those who have had the good fortune to visit Andalusia, that privileged land of the sun, of light, songs, dances, beautiful girls, and bull fighters, preserve, among many other poetical and pleasing recollections, that of election to antique and smiling Cadiz—the "pearl of the ocean and the silver cup," as the Andalusians say in their harmonious and imaginative language. There is, in fact, nothing exaggerated in these epithets, for they translate a true impression. Especially if we arrive by sea, there is nothing so thrilling as the dazzling silhouette which, from afar, is reflected all white from the mirror of a gulf almost always blue.

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The Cadiz peninsula has for centuries been legitimately renowned, for, turn by turn, Phenicians, properly so called, Carthaginians, Romans, Goths, Arabs and Spaniards have made of it the preferred seat of their business and pleasure. In his so often unsparing verses, Martial, even, celebrates with an erotic rapture the undulating suppleness of the ballet dancers of *Gades*, who are continued in our day by the *majas* and *chulas*.

[Illustration: PHENICIAN TOMBS DISCOVERED AT CADIZ.]

For an epoch anterior to that of the Latin poet, we have the testimony, among others, of Strabo, who describes the splendors, formerly and for a long time famous, of the temple of Hercules, and who gives many details, whose accuracy can still be verified, concerning various questions of topography or ethnography. Thus the superb tree called *Dracaena draco* is mentioned as growing in the vicinity of *Gadeira*, the Greek name of the city. Now, some of these trees still exist in certain public and private gardens, and attract so much the more attention in that they are not met with in any other European country. However, although historically Cadiz finds her title to nobility on every page of the Greek and Latin authors, and although her Phenician origin is averred, nowhere has such origin, in a monumental and epigraphic sense, left fewer traces than in the Andalusian peninsula. A few short legends, imperfectly read upon either silver or bronze coins, and that was all, at least up to recent times. Such penury as this distressed savants and even put them into pretty bad humor with the Cadiz archaeologists.

To-day, it seems that the ancient Semitic civilization, which has remained mute for so long in the Iberic territory, is finally willing to yield up her secret, as is proved by the engravings which we present to our readers from photographs taken *in situ*. It is necessary for us to enter into some details.

In 1887 there were met with at the gates of Cadiz, at about five meters beneath the surface of the earth, three rude tombs of shelly limestone, in which were found some skeletons, a few small bronze instruments and some trinkets—the latter of undoubted oriental manufacture.

In one of these tombs was also inclosed a monolithic sarcophagus of white marble of the form called anthropoid and measuring 2.15 m. in length by 0.67 in width. This sarcophagus is now preserved in the local museum, whose director is the active, intelligent and disinterested Father Vera. Although this is not the place to furnish technical or scientific explanations, it will be permitted us to point out the fact that although it is of essentially oriental manufacture, our anthropoid has undoubtedly undergone the Hellenistic influence, which implies an epoch posterior to that of Pericles, who died in 429 B.C. The personage represented, a man of mature age with noble lineaments and aquiline nose, has thick hair corned up on the forehead in

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the form of a crown, and a beard plaited in the Asiatic fashion. As for the head, which is almost entirely executed in round relief, that denotes in an undoubted manner the Hellenistic influence, united, however, with the immutable and somewhat hierarchical traditions of Phenician art. The arms are naked as far as to the elbow, and the feet, summarily indicated, emerge from a long sheath-form robe. As for the arms and hands, they project slightly and are rather outlined than sculptured. The left hand grasps a fruit, the emblem of fecundity, while the right held a painted crown, the traces of which have now entirely disappeared. It suffices to look at this sarcophagus to recognize the exclusively Phenician character of it, and the complete analogy with the monuments of the same species met with in Phenicia, in Cyprus, in Sicily, in Malta, in Sardinia, and everywhere where were established those of Tyre and Sidon, but never until now in Spain.

On another hand, for those of our readers who are interested in archaeology, we believe it our duty to point out as a source of information a memoir published last year by our National Society of Antiquaries. Let us limit ourselves, therefore, to fixing attention upon one important point: The marble anthropoid was protected by a tomb absolutely like the rude tombs contiguous to it.

The successive discoveries since the third of last January at nearly the same place, and at a depth of from 3 to 6 meters beneath the surface, of numerous *loculi* absolutely identical as to material and structure with those of which we have just spoken, is therefore a scientific event of high importance. Those discoveries, which were purely accidental, were brought about by the work on the foundations of the Maritime Arsenal now in course of construction at the gates of Cadiz. Our Fig. 1 represents the unearthing of the *loculi* on the 14th of April, and on the value of which there is no need to dwell. As to the dimensions, it is easy to judge of these, since the laborer standing to the left of the spectator holds in his hand a meter measure serving as a scale. It will suffice to state that the depth of each tomb is about two meters, and that upon the lower part of three of the parallelopipeds there exist pavements of crucial appearance. Finally, nothing denoted externally the existence of these sarcophagi jealously hidden from investigation according to a usage that is established especially by the imprecations graven upon the basaltic casket now preserved in the Museum of the Louvre, and which contained the ashes of Eshmanazar, King of Sidon.

[Illustration: ANTHROPOID SARCOPHAGUS DISCOVERED AT CADIZ.]

Space is wanting to furnish ampler information. Our object is simply to call attention to a zone which is somewhat neglected from a scientific point of view, and which, however, seems as if it ought to offer a valuable field of investigation to students of things Semitic, among whom, as well known, our compatriots hold a rank apart, since it is to them that

falls the laborious and very honorable duty of collecting and editing the inscriptions in Semitic languages.

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On another hand, although in the beginning the sepulchers were taken to pieces and carried away (two of them imperfectly reconstructed may be seen in the garden of the Cadizian Museum), there will be an opportunity of making prevail the system of maintaining *in situ* the various monuments that may hereafter be discovered. Thus only could one, at a given moment, obtain an accurate idea of what the Phenician necropolis of Cadiz was, and allow the structures that compose it to preserve their imposing stamp of rustic indestructibility.

The excavation is being carried on at this very moment, and a bronze statuette of an oriental god and various trinkets of more or less value have just enriched the municipal collection. Let us hope, then, as was recently predicted by Mr. Clermont Ganneau, of the Institute, that some day or another some Semitic inscription will throw a last ray of light upon the past, which is at present so imperfectly known, of Phenician Cadiz.—
L'illustration.

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PREHISTORIC HORSE IN AMERICA.

To the Editor of the Scientific American:

Apropos to Professor Cope's remarks before the A.A.A.S. at Washington, reported in SCIENTIFIC AMERICAN, September 12, inclose sketch of a mounted man, whether on a horse or some other mammal, is a question open to criticism.

[Illustration: Height, 43 in.; length, 63 in. San Rafael del Sur, 1878 Drawn for and forwarded to Peabody Museum—No. 53.]

The figure seems incomplete—whether a cloven foot or toes were intended, cannot say.

A large fossil horse was exhumed in the marsh north of Granada, when ditching in 1863. Then Lake Managua's outlet at Fipitapa ceased its usual supply of water to Lake Nicaragua. When notified of the discovery the spot was under water. Only one of the very large teeth was given to me, which was forwarded to Prof. Baird, of Smithsonian—Private No. 34.

When Lake Nicaragua was an ocean inlet, its track extended to foot hills northward. Its waterworn pebbles and small boulders were subsequently covered by lake deposit, during the time between the inclosure and break out at San Carlos. In this deposit around the lake (now dry) fossil bones occur—elephas, megatherium, horse, etc. The large alluvium plains north of lake, cut through by rivers, allow these bones to settle on their rocky beds. This deposit is of greater depth in places west of lake.

Now, if we suppose these animals were exterminated in glacial times, it remains for us to show when this was consummated.

Subsequent to the lake deposit and exposure no new proofs of its continuance are found.

1. This deposit occurred after the coast range was elevated.
2. Elevation was caused by a volcanic ash eruption, 5 or 6 of a series. (Geologically demonstrated in my letters to *Antiquarian* and *Science*.)

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3. Coast hills inclosed sea sediment, now rock containing fossil leaves.
4. Wash from this sediment, carried with care, formed layers of sandstone, up to ceiling.
5. This ceiling was covered with elaborate inscriptions.
6. The inscription sent you was a near neighbor to cave.
7. Another representing a saurian reptile on large granite boulder is also a neighbor (a glacial dropping).
8. Old river emptying into Lake Managua reveals fossil bones; moraines east of it are found.

From these data we see the glacial action was prior to the sedimentary rock here, and had spent its force when elevation of coast range occurred. No nearer estimate is possible.

As the fossil horse occurs here, our mounted man may have domesticated him, and afterward slaughtered for food like the modern Frenchman. Unfortunately Prof. Cope did not find a similar inscription.

EARL FLINT.

Rivas, Nicaragua, October 27, 1891.

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FURTHER RESEARCHES UPON THE ELEMENT FLUORINE.

By A.E. TUTTON.

Since the publication by M. Moissan of his celebrated paper in the *Annales de Chimie et de Physique* for December, 1887, describing the manner in which he had succeeded in isolating this remarkable gaseous element, a considerable amount of additional information has been acquired concerning the chemical behavior of fluorine, and important additions and improvements have been introduced in the apparatus employed for preparing and experimenting with the gas. M. Moissan now gathers together the results of these subsequent researches—some of which have been published by him from time to time as contributions to various French scientific journals, while others have not hitherto been made known—and publishes them in a long but most interesting paper in the October number of the *Annales de Chimie et de Physique*. Inasmuch as



the experiments described are of so extraordinary a nature, owing to the intense chemical activity of fluorine, and are so important as filling a long existing vacancy in our chemical literature, readers of *Nature* will doubtless be interested in a brief account of them.

IMPROVED APPARATUS FOR PREPARING FLUORINE.

In his paper of 1887, the main outlines of which were given in *Nature* at the time (1887, vol. xxxvii., p. 179), M. Moissan showed that pure hydrofluoric acid readily dissolves the double fluoride of potassium and hydrogen, and that the liquid thus obtained is a good conductor of electricity, rendering electrolysis possible. It will be remembered that, by passing a strong current of electricity through this liquid contained in a platinum apparatus, free gaseous fluorine was obtained at the positive pole and hydrogen at the negative pole. The amount of hydrofluoric acid

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employed in these earlier experiments was about fifteen grms., about six grms. of hydrogen potassium fluoride, HF.KF , being added in order to render it a conductor. Since the publication of that memoir a much larger apparatus has been constructed, in order to obtain the gas in greater quantity for the study of its reactions, and important additions have been made, by means of which the fluorine is delivered in a pure state, free from admixed vapor of the very volatile hydrofluoric acid. As much as a hundred cubic centimeters of hydrofluoric acid, together with twenty grms. of the dissolved double fluoride, are submitted to electrolysis in this new apparatus, and upward of four liters of pure fluorine is delivered by it per hour.

This improved form of the apparatus is shown in the accompanying figure (Fig. 1), which is reproduced from the memoir of M. Moissan. It consists essentially of two parts—the electrolysis apparatus and the purifying vessels. The electrolysis apparatus, a sectional view of which is given in Fig. 2, is similar in form to that described in the paper of 1887, but much larger.

The U-tube of platinum has a capacity of 160 c.c. It is fitted with two lateral delivery tubes of platinum, as in the earlier form, and with stoppers of fluorspar, F , inserted in cylinders of platinum, p , carrying screw threads, which engage with similar threads upon the interior surfaces of the limbs of the U-tube. A key of brass, E , serves to screw or unscrew the stoppers, and between the flange of each stopper and the top of each branch of the U-tube a ring of lead is compressed, by which means hermetic closing is effected. These fluorspar stoppers, which are covered with a coating of gum lac during the electrolysis, carry the electrode rods, t , which are thus perfectly insulated. M. Moissan now employs electrodes of pure platinum instead of irido-platinum, and the interior end of each is thickened into a club shape in order the longer to withstand corrosion. The apparatus is immersed during the electrolysis in a bath of liquid methyl chloride, maintained in tranquil ebullition at -23° . In order to preserve the methyl chloride as long as possible, the cylinder containing it is placed in an outer glass cylinder containing fragments of calcium chloride; by this means it is surrounded with a layer of dry air, a bad conductor of heat.

The purifying vessels are three in number. The first consists of a platinum spiral worm-tube of about 40 c.c. capacity, immersed also in a bath of liquid methyl chloride, maintained at as low a temperature as possible, about -50° . As hydrofluoric acid boils at 19.5° . (Moissan), almost the whole of the vapor of this substance which is carried away in the stream of issuing fluorine is condensed and retained at the bottom of the worm. To remove the last traces of hydrofluoric acid, advantage is taken of the fact that fused sodium fluoride combines with the free acid with great energy to form the double

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fluoride HF.NaF. Sodium fluoride also possesses the advantage of not attracting moisture. After traversing the worm condenser, therefore, the fluorine is caused to pass through two platinum tubes filled with fragments of fused sodium fluoride, from which it issues in an almost perfect state of purity. The junctions between the various parts of the apparatus are effected by means of screw joints, between the nuts and flanges of which collars of lead are compressed. During the electrolysis these leaden collars become, where exposed to the gaseous fluorine, rapidly converted into lead fluoride, which being greater in bulk causes the joints to become hermetically sealed. In order to effect the electrolysis, twenty-six to twenty-eight Bunsen elements are employed, arranged in series. An ampere meter and a commutator are introduced between the battery and the electrolysis apparatus; the former affording an excellent indication of the progress of the electrolysis.

[Illustration: FIG. 1.—FLUORINE APPARATUS.]

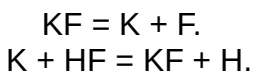
As the U-tube contains far more hydrofluoric acid than can be used in one day, each lateral delivery tube is fitted with a metallic screw stopper, so that the experiments may be discontinued at any time, and the apparatus closed. The whole electrolysis vessel is then placed under a glass bell jar containing dry air, and kept in a refrigerator until again required for use. In this way it may be preserved full of acid for several weeks, ready at any time for the preparation of the gas. Considerable care requires to be exercised not to admit the vapor of methyl chloride into the U-tube, as otherwise violent detonations are liable to occur. When the liquid methyl chloride is being introduced into the cylinder, the whole apparatus becomes surrounded with an atmosphere of its vapor, and as the platinum U-tube is at the same instant suddenly cooled the vapor is liable to enter by the abducting tubes. Consequently, as soon as the current is allowed to pass and fluorine is liberated within the U-tube, an explosion occurs. Fluorine instantly decomposes methyl chloride, with production of flame and formation of fluorides of hydrogen and carbon, liberation of chlorine, and occasionally deposition of carbon. In order to avoid this unpleasant occurrence, when the methyl chloride is being introduced the ends of the lateral delivery tubes are attached to long lengths of caoutchouc tubing, supplied at their ends with calcium chloride drying tubes, so as to convey dry air from outside the atmosphere of methyl chloride vapor. If great care is taken to obtain the minimum temperature, this difficulty may be even more simply overcome by employing a mixture of well pounded ice and salt instead of methyl chloride; but there is the counterbalancing disadvantage to be considered, that such a cooling bath requires much more frequent renewal.

[Illustration: FIG. 2.]

CHEMICAL REACTIONS OCCURRING DURING THE ELECTROLYSIS.

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In the paper of 1887, M. Moissan adopted the view that the first action of the electric current was to effect the decomposition of the potassium fluoride contained in solution in the hydrofluoric acid, fluorine being liberated at the positive pole and potassium at the negative terminal. This liberated potassium would at once regenerate potassium fluoride in presence of hydrofluoric acid, and liberate its equivalent of hydrogen:



But when the progress of the electrolysis is carefully followed, by consulting the indications of the amperemeter placed in circuit, it is found to be by no means as regular as the preceding formulae would indicate. With the new apparatus, the decomposition is quite irregular at first, and does not attain regularity until it has been proceeding for upward of two hours. Upon stopping the current and unmounting the apparatus, the platinum rod upon which the fluorine was liberated is found to be largely corroded, and at the bottom of the U-tube a quantity of a black, finely divided substance is observed. This black substance, which was taken at first to be metallic platinum, is a complex compound containing one equivalent of potassium to one equivalent of platinum, together with a considerable proportion of fluorine.

Moreover, the hydrofluoric acid is found to contain a small quantity of platinum fluoride in solution. The electrolytic reaction is probably therefore much more complicated than was at first considered to be the case. The mixture of acid and alkaline fluoride furnishes fluorine at the positive terminal rod, but this intensely active gas, in its nascent state, attacks the platinum and produces platinum tetrafluoride, PtF_4 ; this probably unites with the potassium fluoride to form a double salt, possibly 2Kl.PtF_4 , analogous to the well known platinochloride 2KCl.PtCl_4 ; and it is only when the liquid contains this double salt that the electrolysis proceeds in a regular manner, yielding free fluorine at the positive pole, and hydrogen and the complex black compound at the negative pole.

PHYSICAL PROPERTIES OF FLUORINE.

Fluorine possesses an odor which M. Moissan compares to a mixture of hypochlorous acid and nitrogen peroxide, but this odor is usually masked by that of the ozone which it always produces in moist air, owing to its decomposition of the water vapor. It produces most serious irritation of the bronchial tubes and mucous membrane of the nasal cavities, the effects of which are persistent for quite a fortnight.

When examined in a thickness of one meter, it is seen to possess a greenish yellow color, but paler, and containing more of yellow, than that of chlorine. In such a layer, fluorine does not present any absorption bands. Its spectrum exhibits thirteen bright,

lines in the red, between wave lengths 744 and 623. Their positions and relative intensities are as follows:

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$[\lambda] = 744$ very feeble. | $[\lambda] = 685.5$ feeble
740 " | 683.5 "
734 " | 677 strong
714 feeble. | 640.5 "
704 " | 634 "
691 " | 623 "
687.5 " |

At a temperature of -95 deg. at ordinary atmospheric pressure, fluorine remains gaseous, no sign of liquefaction having been observed.

METHODS OF EXPERIMENTING WITH FLUORINE.

When it is desired to determine the action of fluorine upon a solid substance, the following method of procedure is adopted. A preliminary experiment is first made, in order to obtain some idea as to the degree of energy of the reaction, by bringing a little of the solid, placed upon the lid of a platinum crucible held in a pair of tongs, near the mouth of the delivery tube of the preparation apparatus. If a gaseous or liquid product results, and it is desirable to collect it for examination, small fragments of the solid are placed in a platinum tube connected to the delivery tube by flexible platinum tubing or by a screw joint, and the resulting gas may be collected over water or mercury, or the liquid condensed in a cooled cylinder of platinum. In this manner the action of fluorine upon sulphur and iodine has been studied. If the solid, phosphorus for instance, attacks platinum, or the temperature of the reaction is sufficiently high to determine the combination of platinum and fluorine (toward 500 deg.), a tube of fluorspar is substituted for the platinum tube. The fluorspar tubes employed by M. Moissan for the study of the action of phosphorus were about twelve to fourteen centimeters long, and were terminated by platinum ends furnished with flanges and screw threads in order to be able to connect them with the preparation apparatus. If it is required to heat the fluorspar tubes, they are surrounded by a closely wound copper spiral, which may be heated by a Bunsen flame.

In experimenting upon liquids, great care is necessary, as the reaction frequently occurs with explosive violence. A preliminary experiment is therefore always made, by allowing the fluorine delivery tube to dip just beneath the surface of the liquid contained in a small glass cylinder. When the liquid contains water, or when hydrofluoric acid is a product of the reaction, cylinders of platinum or of fluorspar are employed. If it is required to collect and examine the product, the liquid is placed along the bottom of a horizontal tube of platinum or fluorspar, as in case of solids, connected directly with the preparation apparatus, and the product is collected over water or mercury if a gas, or in a cooled platinum receiver if a liquid.

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During the examination of liquids a means has accidentally been discovered by which a glass tube may be filled with fluorine gas. A few liquids, one of which is carbon tetrachloride, react only very slowly with fluorine at the ordinary temperature. By filling a glass tube with such a liquid, and inverting it over a platinum capsule also containing the liquid, it is possible to displace the liquid by fluorine, which, as the walls are wet, does not attack the glass. Or the glass tube may be filled with the liquid, and then the latter poured out, leaving the walls wet; the tube may then be filled with fluorine gas, which being slightly heavier than air, remains in the tube for some time. In one experiment, in which a glass test tube had been filled with fluorine over carbon tetrachloride, it was attempted to transfer it to a graduated tube over mercury, but in inclining the test tube for this purpose the mercury suddenly came in contact with the fluorine, and absorbed it so instantaneously and with such a violent detonation that both the test tube and the graduated tube were shattered into fragments. Indeed, owing to the powerful affinity of mercury for fluorine, it is a most dangerous experiment to transfer a tube containing fluorine gas, filled according to either the first or second method, to the mercury trough; the tube is always shattered if the mercury comes in contact with the gas, and generally with a loud detonation. Fluorine may, however, be preserved for some time in tubes over mercury, provided a few drops of the non-reacting liquid are kept above the mercury meniscus.

For studying the action of fluorine on gases, a special piece of apparatus, shown in Fig. 3, has been constructed. It is composed of a tube of platinum, fifteen centimeters long, closed by two plates of clear, transparent, and colorless fluorspar, and carrying three lateral narrower tubes also of platinum. Two of these tubes face each other in the center of the apparatus, and serve one for the conveyance of the fluorine and the other of the gas to be experimented upon. The third, which is of somewhat greater diameter than the other two, serves as exit tube for the product or products of the reaction, and may be placed in connection with a trough containing either water or mercury.

The apparatus is first filled with the gas to be experimented upon, then the fluorine is allowed to enter, and an observation of what occurs may be made through the fluorspar windows. One most important precaution to take in collecting the gaseous products over mercury is not to permit the platinum delivery tube to dip more than two or at most three millimeters under the mercury, as otherwise the levels of the liquid in the two limbs of the electrolysis U-tube become so different, owing to the pressure, that the fluorine from one side mixes with the hydrogen evolved upon the other, and there is a violent explosion.

[Illustration: FIG. 3.]

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ACTION OF FLUORINE UPON THE NON-METALLIC ELEMENTS.

Hydrogen.—As just described, hydrogen combines with fluorine, even at -23 deg. and in the dark, with explosive force. This is the only case in which two elementary gases unite directly without the intervention of extraneous energy. If the end of the tube delivering fluorine is placed in an atmosphere of hydrogen, a very hot blue flame, bordered with red, at once appears at the mouth of the tube, and vapor of hydrofluoric acid is produced.

Oxygen.—Fluorine has not been found capable of uniting with oxygen up to a temperature of 500 deg.. On ozone, however, it appears to exert some action, as will be evident from the following experiment. It was shown in 1887 that fluorine decomposes water, forming hydrofluoric acid, and liberating oxygen in the form of ozone. When a few drops of water are placed in the apparatus shown in Fig. 3, and fluorine allowed to enter, the water is instantly decomposed, and on looking through the flourspar ends a thick dark cloud is seen over the spot where each drop of water had previously been. This cloud soon diminishes in intensity, and is eventually replaced by a beautiful blue gas—ozone in a state of considerable density. If the product is chased out by a stream of nitrogen as soon as the dense cloud is formed, a very strong odor is perceived, different from that of either fluorine or ozone, but which soon gives place to the unmistakable odor of ozone. It appears as if there is at first produced an unstable oxide of fluorine, which rapidly decomposes into fluorine and ozone.

Nitrogen and chlorine appear not to react with fluorine.

Sulphur.—In contact with fluorine gas, sulphur rapidly melts and inflames. A gaseous fluoride of sulphur is formed, which possesses a most penetrating odor, somewhat resembling that of chloride of sulphur. The gas is incombustible, even in oxygen. When warmed in a glass vessel, the latter becomes etched, owing to the formation of silicon tetrafluoride, SiF_4 . Selenium and tellurium behave similarly, but form crystalline solid fluorides.

Bromine vapor combines with fluorine in the cold with production of a very bright but low temperature dame. If the fluorine is evolved in the midst of pure dry liquid bromine, the combination is immediate, and occurs without flame.

Iodine.—When fluorine is passed over a fragment of iodine contained in the horizontal tube, combination occurs, with production of a pale flame. A very heavy liquid, colorless when free from dissolved iodine, and fuming strongly in the air, condenses in the cooled receiver. This liquid fluoride of iodine attacks glass with great energy and decomposes water when dropped into that liquid with a noise like that produced by red-hot iron. Its

properties agree with those of the fluoride of iodine prepared by Gore by the action of iodine on silver fluoride.

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Phosphorus.—Immediately phosphorus, either the ordinary yellow variety or red phosphorus, comes in contact with fluorine, a most lively action occurs, accompanied by vivid incandescence. If the fluorine is in excess, a fuming gas is evolved, which gives up its excess of fluorine on collecting over mercury, and is soluble in water. This gas is phosphorus pentafluoride, PF_5 , prepared some years ago by Prof. Thorpe. If, on the contrary, the phosphorus is in excess, a gaseous mixture of this pentafluoride with a new fluoride, the trifluoride, PF_3 , a gas insoluble in water, but which may be absorbed by caustic potash, is obtained. The trifluoride, in turn, combines with more fluorine to form the pentafluoride, the reaction being accompanied by the appearance of a flame of comparatively low temperature.

Arsenic combines with fluorine at the ordinary temperature with incandescence. If the current of fluorine is fairly rapid, a colorless fuming liquid condenses in the receiver, which is mainly arsenic trifluoride, AsF_3 , but which appears also to contain a new fluoride, the pentafluoride, AsF_5 , inasmuch as the solution in water yields the reactions of both arsenious and arsenic acids.

Carbon.—Chlorine does not unite with carbon even at the high temperature of the electric arc, but fluorine reacts even at the ordinary temperature with finely divided carbon. Purified lampblack inflames instantly with great brilliancy, as do also the lighter varieties of wood charcoal. A curious phenomenon is noticed with wood charcoal; it appears at first to absorb and condense the fluorine, then quite suddenly it bursts into flame with bright scintillations. The denser varieties of charcoal require warming to 50 deg. or 60 deg. before they inflame, but once the combustion is started at any point it rapidly propagates itself throughout the entire piece. Graphite must be heated to just below dull redness in order to effect combination; while the diamond has not yet been attacked by fluorine, even at the temperature of the Bunsen flame. A mixture of gaseous fluorides of carbon are produced whenever carbon of any variety is acted upon by fluorine, the predominating constituent being the tetrafluoride, CF_4 .

Boron.—The amorphous variety of boron inflames instantly in fluorine, with projection of brilliant sparks and liberation of dense fumes of boron trifluoride, BF_3 . The adamantine modification behaves similarly if powdered. When the experiment is performed in the fluorspar tube, the gaseous fluoride may be collected over mercury. The gas fumes strongly in the air, and is instantly decomposed by water.

Silicon.—The reaction between fluorine and silicon is one of the most beautiful of all these extraordinary manifestations of chemical activity. The cold crystals become immediately white-hot, and the silicon burns with a very hot flame, scattering showers of star-like, white-hot particles in all directions. If the action is stopped before all the silicon is consumed, the residue is found to be fused. As crystalline silicon only melts at a temperature superior to 1,200 deg., the heat evolved must be very great. If the reaction is performed in the fluorspar tube, the resulting gaseous silicon tetrafluoride, SiF_4 , may be collected over mercury.

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Amorphous silicon likewise burns with great energy in fluorine.

ACTION OF FLUORINE UPON METALS.

Sodium and *potassium* combine with fluorine with great vigor at ordinary temperatures, becoming incandescent, and forming their respective fluorides, which may be obtained crystallized from water in cubes. Metallic *calcium* also burns in fluorine gas, forming the fused fluoride, and occasionally minute crystals of fluorspar. *Thallium* is rapidly converted to fluoride at ordinary temperatures, the temperature rising until the metal melts and finally becomes red hot. Powdered *magnesium* burns with great brilliancy. *Iron*, reduced by hydrogen, combines in the cold with immediate incandescence, and formation of an anhydrous, readily soluble, white fluoride. *Aluminum*, on heating to low redness, gives a very beautiful luminosity, as do also *chromium* and *manganese*. The combustion of slightly warmed zinc in fluorine is particularly pretty as an experiment, the flame being of a most dazzling whiteness. *Antimony* takes fire at the ordinary temperature, and forms a solid white fluoride. *Lead* and *mercury* are attacked in the cold, as previously described, the latter with great rapidity. *Copper* reacts at low redness, but in a strangely feeble manner, and the white fumes formed appear to combine with a further quantity of fluorine to form a perfluoride. The main product is a volatile white fluoride. *Silver* is only slowly attacked in the cold. When heated, however, to 100 deg., the metal commences to be covered with a yellow coat of anhydrous fluoride, and on heating to low redness combination occurs, with incandescence, and the resulting fluoride becomes fused, and afterward presents a satin-like aspect. *Gold* becomes converted into a yellow deliquescent volatile fluoride when heated to low redness, and at a slightly higher temperature the fluoride is dissociated into metallic gold and fluorine gas.

The action of fluorine on *platinum* has been studied with special care. It is evident, in view of the corrosion of the positive platinum terminal of the electrolysis apparatus, that nascent fluorine rapidly attacks platinum at a temperature of -23 deg.. At 100 deg., however, fluorine gas appears to be without action on platinum. At 500 deg.-600 deg. it is attacked strongly, with formation of the tetrafluoride, PtF_4 , and a small quantity of the protofluoride, PtF_2 . If the fluorine is admixed with vapor of hydrofluoric acid, the reaction is much more vigorous, as if a fluorhydrate of the tetrafluoride, perhaps $2\text{HF} \cdot \text{PtF}_4$, were formed. The tetrafluoride is generally found in the form of deep-red fused masses, or small yellow crystals resembling those of anhydrous platinum chloride. The salt is volatile and very hygroscopic. Its behavior with water is peculiar. With a small quantity of water a brownish yellow solution

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is formed, which, however, in a very short time becomes warm and the fluoride decomposes; platinic hydrate is precipitated, and free hydrofluoric acid remains in solution. If the quantity of water is greater, the solution may be preserved for some minutes without decomposition. If the liquid is boiled, it decomposes instantly. At a red heat platinic fluoride decomposes into metallic platinum and fluorine, which is evolved in the free state. This reaction can therefore be employed as a ready means of preparing fluorine, the fluoride only requiring to be heated rapidly to redness in a platinum tube closed at one end, when crystallized silicon held at the open end will be found to immediately take fire in the escaping fluorine. The best mode of obtaining the fluoride of platinum for this purpose is to heat a bundle of platinum wires to low redness in the fluorspar reaction tube in a rapid stream of fluorine. As soon as sufficient fluoride is formed on the wires, they are transferred to a well stoppered dry glass tube, until required for the preparation of fluorine.

ACTION OF FLUORINE UPON NON-METALLIC COMPOUNDS.

Sulphureted Hydrogen.—When the horizontal tube shown in Fig. 3 is filled with sulphureted hydrogen gas and fluorine is allowed to enter, a blue flame is observed on looking through the fluorspar windows playing around the spot where the fluorine is being admitted. The decomposition continues until the whole of the hydrogen sulphide is converted into gaseous fluorides of hydrogen and sulphur.

Sulphur dioxide is likewise decomposed in the cold, with production of a yellow flame and formation of fluoride of sulphur.

Hydrochloric acid gas is also decomposed at ordinary temperatures with flame, and, if there is not a large excess of hydrochloric acid present, with detonation. Hydrofluoric acid and free chlorine are the products.

Gaseous *hydrobromic* and *hydriodic acids* react with fluorine in a similar manner, with production of flame and formation of hydrofluoric acid. Inasmuch, however, as bromine and iodine combine with fluorine, as previously described, these halogens do not escape, but burn up to their respective fluorides. When fluorine is delivered into an aqueous solution of hydriodic acid, each bubble as it enters produces a flash of flame, and if the fluorine is being evolved fairly rapidly there is a series of very violent detonations. A curious reaction also occurs when fluorine is similarly passed into a 50 per cent. aqueous solution of hydrofluoric acid itself, a flame being produced in the middle of the liquid, accompanied by a series of detonations.



Nitric acid vapor reacts with great violence with fluorine, a loud explosion resulting. If fluorine is passed into the ordinary liquid acid, each bubble as it enters produces a flame in the liquid.

Ammonia gas is decomposed by fluorine with formation of a yellow flame, forming hydrofluoric acid and liberating nitrogen. With a solution of the gas in water, each bubble of fluorine produces an explosion and flame, as in case of hydriodic acid.

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Phosphoric anhydride, when heated to low redness, burns with a pale flame in fluorine, forming a gaseous mixture of fluorides and oxyfluoride of phosphorus. *Pentachloride and trichloride of phosphorus* both react most energetically with fluorine, instantly producing a brilliant flame, and evolving a mixture of phosphorus pentafluoride and free chlorine.

Arsenious anhydride also affords a brilliant combustion, forming the liquid trifluoride of arsenic, AsF_3 . This liquid in turn appears to react with more fluorine with considerable evolution of heat, probably forming the pentafluoride, AsF_5 . *Chloride of arsenic*, AsCl_3 , is converted with considerable energy to the trifluoride, free chlorine being liberated.

Carbon bisulphide inflames in the cold in contact with fluorine, and if the fluorine is led into the midst of the liquid a similar production of flame occurs under the surface of the liquid, as in case of nitric acid. No carbon is deposited, both the carbon and sulphur being entirely converted into gaseous fluorides.

Carbon tetrachloride, as previously mentioned, reacts only very slowly with fluorine. The liquid may be saturated with gaseous fluorine at 15 deg., but on boiling this liquid a gaseous mixture is evolved, one constituent of which is carbon tetrafluoride, CF_4 , a gas readily capable of absorption by alcoholic potash. The remainder consists of another fluoride of carbon, incapable of absorption by potash and chlorine. A mixture of the vapors of carbon tetrachloride and fluorine inflames spontaneously with detonation, and chlorine is liberated without deposition of carbon.

Boric anhydride is raised to a most vivid incandescence by fluorine, the experiment being rendered very beautiful by the abundant white fumes of the trifluoride which are liberated.

Silicon dioxide, one of the most inert of substances at the ordinary temperature, takes fire in the cold in contact with fluorine, becoming instantly white-hot, and rapidly disappearing in the form of silicon tetrafluoride. The *chlorides* of both *boron* and *silicon* are decomposed by fluorine, with formation of fluorides and liberation of chlorine, the reaction being accompanied by the production of flame.

ACTION OF FLUORINE UPON METALLIC COMPOUNDS.

Chlorides of the metals are instantly decomposed by fluorine, generally at the ordinary temperature, and in certain cases, antimony trichloride for instance, with the appearance of flame. Chlorine is in each case liberated, and a fluoride of the metal formed. A few require heating, when a similar decomposition occurs, often accompanied by incandescence, as in case of chromium sesquichloride.

Bromides and *iodides* are decomposed with even greater energy, and the liberated bromine and iodine burn in the fluorine with formation of their respective fluorides.

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Cyanides react in a most beautiful manner with fluorine, the displaced cyanogen burning with a purple flame. Potassium ferrocyanide in particular affords a very pretty experiment, and reacts in the cold. Ordinary potassium cyanide requires slightly warming in order to start the combustion.

Fused *potash* yields potassium fluoride and ozone. Aqueous potash does not form potassium hypofluorite when fluorine is bubbled into it, but only potassium fluoride. *Lime* becomes most brilliantly incandescent, owing partly to the excess being raised to a very high temperature by the heat developed during the decomposition, and partly to the phosphorescence of the calcium fluoride formed.

Sulphides of the alkalies and alkaline earths are also immediately rendered incandescent, fluorides of the metal and sulphur being respectively formed.

Boron nitride behaves in an exceedingly beautiful manner, being attacked in the cold, and emitting a brilliant blue light which is surrounded by a halo of the fumes of boron fluoride.

Sulphates, *nitrates* and *phosphates* generally require the application of more or less heat, when they too are rapidly and energetically decomposed. Calcium phosphate is attacked in the cold like lime, giving out a brilliant white light, and producing calcium fluoride and gaseous oxyfluoride of phosphorus, $\text{POF}_{\{3\}}$. *Calcium carbonate* also becomes raised to brilliant incandescence when exposed to fluorine gas, as does also normal *sodium carbonate*; but curiously enough the bicarbonates of the alkalies do not react with fluorine even at red heat. Perhaps this may be explained by the fact that fluorine has no action at available temperatures upon carbon dioxide.

ACTION OF FLUORINE UPON A FEW ORGANIC COMPOUNDS.

Chloroform.—When chloroform is saturated with fluorine, and subsequently boiled, carbon tetrafluoride, hydrofluoric acid and chlorine are evolved. If a drop of chloroform is agitated in a glass tube with excess of fluorine, a violent explosion suddenly occurs, accompanied by a flash of flame, and the tube is shattered to pieces. The reaction is very lively when fluorine is evolved in the midst of a quantity of chloroform, a persistent flame burns beneath the surface of the liquid, carbon is deposited, and fluorides of hydrogen and carbon are evolved together with chlorine.

Methyl chloride is decomposed by fluorine, even at -23°C , with production of a yellow flame, deposition of carbon, and liberation of fluorides of hydrogen and carbon and free chlorine. With the vapor of methyl chloride, as pointed out in the description of the electrolysis, violent explosions occur.



Ethyl alcohol vapor at once takes fire in fluorine gas, and the liquid is decomposed with explosive violence without deposition of carbon. Aldehyde is formed to a considerable extent during the reaction.

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Acetic acid and *benzene* are both decomposed with violence, their cold vapors burn in fluorine, and when the latter is bubbled through the liquids themselves, flashes of flame, and often most dangerous explosions, occur. In the case of benzene, carbon is deposited, and with both liquids fluorides of hydrogen and carbon are evolved. *Aniline* likewise takes fire in fluorine, and deposits a large quantity of carbon, which, however, if the fluorine is in excess, burns away completely to carbon tetrafluoride.

Such are the main outlines of these later researches of M. Moissan, and they cannot fail to impress those who read them with the prodigious nature of the forces associated with those minutest of entities, the chemical atoms, as exhibited at their maximum, in so far as our knowledge at present goes, in the case of the element fluorine.—*Nature*.

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APPARATUS FOR THE ESTIMATION OF FAT IN MILK.

By E. MOLISABI.

[Illustration]

The author, after criticising the various methods for estimating fat in milk which have been proposed from time to time, agrees with Stokes (*Analyst*, 1885, p. 48), Eustace Hill (*Analyst*, 1891, p. 67), and Bondzynsky (*Landwirth Jahrb. der Schweiz*, 1889), that the method of Werner Schmid is the simplest, most rapid, and convenient hitherto introduced. The conditions tending to inaccuracy are: The employment of ether containing alcohol; boiling the mixture of milk and acid too long, when a caramel-like body is formed, soluble in ether; the difficulty of reading off the volume of ether left in the tube, owing to the gradations of the instrument being obscured by the flocculent layer of casein; when only a portion of the ether is used, fat may be left behind in the acid mixture, as shown by Allen (*Chem. Zeit.*, 1891, p. 331). The author believes that by the invention of the simple apparatus represented in the accompanying figure, he has rendered the process both accurate and convenient. This consists of a flask B of about 75 c.c. capacity, which has a glass tap fused on, with two capillary tubes attached, the one passing upward, the other downward. The neck of flask B is ground into the neck of flask A, which holds about 90 c.c. Either of the flasks can be placed in communication with the external air by the opening *a*. The ether must be previously washed with one or two tenths of its volume of water, to remove traces of alcohol. The operation is performed as follows: 10 c.c. of well mixed milk are weighed in (or measured into) flask A, 10 c.c. of hydrochloric acid added, and the mixture heated to boiling on an asbestos sheet. The boiling must not exceed a minute and a half, the fluid being shaken from time to time, and not allowed to become of a deeper color than a dark brown [not black]. The flask is cooled, and 25 c.c. of ether added.

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The two flasks are connected as shown in the figure, the tap closed, and the whole shaken for a few minutes, the flask being vented two or three times by the opening a. The apparatus is now inverted, allowed to stand five or six minutes, the tap turned, and the dark acid liquid drawn off into flask B. By a little shaking of the ether the whole of the acid liquid may be easily got into the lower flask. The apparatus is again inverted, then separated, 10 c.c. of ether are introduced into the flask B, the tap closed, and the fluids well shaken. When the ether layer is distinct, the acid liquor is run off, and the ether solution transferred to A. The whole of the ether solution is washed in the apparatus two or three times with a little water, the flask A removed to the water bath, the ether driven off, the last traces of ether and water being removed by placing the flask in a drying oven heated from 107 to 110 deg. C., where it must remain at least twenty minutes. The usual cooling in the exsiccator and weighing concludes the operation. Examples are given showing its concordance with the Adams and other recognized processes. Sour milk, which must be weighed in the flask, can be conveniently analyzed; also cream, using 5 grammes cream and 10 c.c. hydrochloric acid. (*Berichte Deutsch. Chem. Gesell.*, 24, p. 2204).—*The Analyst*.

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AMERICAN ASSOCIATION—NINTH ANNUAL REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.[1]

[Footnote 1: From advance proof sheets of the Proceedings of the American Association for the Advancement of Science; Washington meeting, 1891.]

The Committee on Indexing Chemical Literature respectfully presents to the Chemical Section its ninth annual report.

Since our last meeting the following bibliographies have been printed:

1. A Bibliography of Geometrical Isomerism. Accompanying an address on this subject to the Chemical Section of the American Association for the Advancement of Science at Indianapolis, August, 1890, by Professor Robert B. Warder, Vice President. Proceedings A.A.A.S., vol. xxxix. Salem, 1890. 8vo.
2. A Bibliography of the Chemical Influence of Light, by Alfred Tuckerman. Smithsonian Miscellaneous Collections No. 785. Washington, D.C., 1891. Pp. 22. 8vo.
3. A Bibliography of Analytical Chemistry for the year 1890, by H. Carrington Bolton. J. Anal. Appl. Chem., v., No. 3. March, 1891.

We chronicle the publication of the following important bibliography:

4. A Guide to the Literature of Sugar. A book of reference for chemists, botanists, librarians, manufacturers and planters, with comprehensive subject index. By H. Ling Roth. London: Kegan Paul, Trench, Trubner & Co. Limited. 1890. 8vo. Pp xvi-159.

This work contains more than 1,200 titles of books, pamphlets, and papers relating to sugar. Many of the titles are supplemented with brief abstracts. The alphabetical author catalogue is followed by a chronological table and an analytical subject index. The compilation extends to the beginning of the year 1885, and the author promises a supplement and possibly an annual guide.

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The ambitious work is useful but very incomplete. It does not include glucose. The author gives a list of fifteen periodicals devoted to sugar, and omits exactly fifteen more recorded in Bolton's *Catalogue of Scientific and Technical Periodicals* (1665-1882). Angelo Sala's *Saccharologia* is not named, though mentioned in Roscoe and Schorlemmer and elsewhere.

Notwithstanding some blemishes, this work is indispensable to chemists desirous of becoming familiar with the literature of sugar. It is to be hoped that a second edition brought down to date may be issued by the author.

5. A Bibliography of Ptomaines accompanies Professor Victor C. Vaughan's work, Ptomaines and Leucomaines. Philadelphia, 1888. (Pages 296-814.) 8vo.

Chemists will hail with pleasure the announcement that a new dictionary of solubilities is in progress by a competent hand. Professor Arthur M. Comey, of Tufts College, College Hill, Mass., writes that the work he has undertaken will be as complete as possible. "The very old matter which forms so large a part of Storer's Dictionary will be referred to, and in important cases fully given. Abbreviations will be freely used and formulae will be given instead of the chemical names of substances, in the body of the book. This is found to be absolutely necessary in order to bring the work into a convenient size for use ..., The arrangement will be strictly alphabetical. References to original papers will be given in all cases ..."

Professor Comey estimates his work will contain over 70,000 entries, and will make a volume of 1,500-1,700 pages.

The following letter from Mr. Howard L. Prince, Librarian of the United States Patent Office, explains itself:

WASHINGTON, D.C., February 11, 1891

Dr. H Carrington Bolton.
University Club, New York, N.Y.:

DEAR SIR—In response to your request I take pleasure in giving you the following information regarding the past accomplishments and plans for the future of the Scientific Library in the matter of technological indexing. The work of indexing periodicals has been carried on in the library for some years in a somewhat desultory fashion, taking up one journal after another, the object being, apparently, more to supply clerks with work than the pursuance of any well defined plan. However, one important work has been substantially completed, viz., a general index to the whole set of the SCIENTIFIC AMERICAN and SUPPLEMENT from 1846 to date. It is unnecessary for me to point out to you the importance of this work, embracing a collection which has held the leading place in the line of general information on invention and progress, the labor of compiling

which has been so formidable that no movement in that direction has been attempted by the publishers except in regard to the SUPPLEMENT only, and that very imperfectly.

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This index embraces now 184,600 cards, not punched, and at present stored in shallow drawers and fastened by rubber bands, and of course they are at present unavailable for use. There is little prospect of printing this index, and I have been endeavoring for some time to throw the index open to the public by punching the cards and fastening them with guard rods, but as yet have made no perceptible impression upon the authorities, although the expense of preparation would be only about \$70.

There has also been completed an index to the English journal *Engineering*, comprising 84,000 cards, from the beginning to date.

An index to Dingler's *Polytechnisches Journal* was also commenced as long ago as 1878, carried on for six or seven years and then dropped. I hope, however, at no remote date, to bring this forward to the present time. On taking charge of the library I was at once impressed with the immense value of the periodical literature on our shelves and the great importance of making it more readily accessible, and have had in contemplation for some time the beginning of a card index to all our periodicals on the same general plan as that of Rieth's Repertorium. I have, however, been unable to obtain sufficient force to cover the whole ground, but have selected about one hundred and fifty journals, notably those upon the subjects of chemistry, electricity and engineering, both in English and foreign languages, the indexing of which has been in progress since the first of January. This number includes substantially all the valuable material in our possession in the English language, not only journals, but transactions of societies, all the electrical journals and nearly all the chemical in foreign languages. This index will be kept open to the public as soon as sufficient material has accumulated. In general plan it will be alphabetical, following nearly the arrangement of the periodical portion of the surgeon general's catalogue. I shall depart from the strictly alphabetical plan sufficiently to group under such important subjects as chemistry, electricity, engineering, railroads, etc., all the subdivisions of the art, so that the electrical investigator, for instance, will not be obliged to travel from one end of the alphabet to the other to find the divisions of generators, conductors, dynamos, telephones, telegraphs, etc., and in the grouping of the classes of applied science the office classification of inventions will, as a rule, be adhered to, the subdivisions being, of course, arranged in alphabetical order under their general head and the title of the several articles also arranged alphabetically by authors or principal words.

With many thanks for the kind interest and valuable information afforded me, I remain, very truly yours,

HOWARD L. PRINCE,
Librarian Scientific Library.



The committee much prefers to record completed work than to mention projects, as the latter sometimes fail. It is satisfactory, however, to announce that the indefatigable indexer, Dr. Alfred Tuckerman, is engaged on an extensive Bibliography of Mineral Waters. The chairman of the committee expects to complete the MS. of a Select Bibliography of Chemistry during the year, visiting the chief libraries of Europe for the purpose this summer.



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H. CARRINGTON BOLTON, Chairman.
F.W. CLARKE,
ALBERT R. LEEDS,
ALEXIS A. JULIEN,
JOHN W. LANGLEY,
ALBERT B. PRESCOTT.

[Dr. Alfred Tuckerman was added to the committee at the Washington meeting to fill a vacancy.]

* * * * *

THE FRENCH WINE LAW.

The French wine law (*Journ. Officiel*, July 11, 1891) includes the following provisions:

Sect. 1. The product of fermentation of the husks of grapes from which the must has been extracted with water, with or without the addition of sugar, or mixed with wine in whatever proportion, may only be sold, or offered for sale, under the name of husk wine or sugared wine.

Sect. 2. The addition of the following substances to wine, husk wine, sugared wine, or raisin wine will be considered an adulteration:

1. Coloring matters of all descriptions.
2. Sulphuric, nitric, hydrochloric, salicylic, boric acid, or similar substances.
3. Sodium chloride beyond one gramme per liter.

Sect. 3. The sale of plastered wines, containing more than two grammes of potassium, or sodium sulphate, is prohibited.

Offenders are subject to a fine of 16 to 500 francs, or to imprisonment from six days to three months, according to circumstances.

Barrels or vessels containing plastered wine must have affixed a notice to that effect in large letters, and the books, invoices, and bills of lading must likewise bear such notice.

* * * * *

THE ALLOTROPIC CONDITIONS OF SILVER.

M. Berthelot recently called the attention of the Academy (Paris) to the memoirs of Carey Lea on the allotropic states of silver, and exhibited specimens of the color of gold and others of a purple color sent him by the author. He explained the importance of these results, which remind us of the work of the ancient alchemists, but he reserved the question whether these substances are really isomeric states of silver or complex and condensed compounds, sharing the properties of the element which constituted the principal mass (97-98 per cent.), conformably to the facts known in the history of the various carbons, of the derivatives of red phosphorus, and especially of the varieties of iron and steel. Between these condensed compounds and the pure elements the continuous transition of the physical and chemical properties is often effected by insensible degrees, by a mixture of definite compounds.

The following letter appears in a recent number of the *Chemical News*.

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Sir: In a recently published lecture, Mr. Meldola seems to call in question the existence of allotropic silver. This opinion does not appear, however, to be based on any adequate study of the subject, but to be somewhat conjectural in its nature. No experimental support of any sort is given, and the only argument offered (if such it can be called) is that this altered form of silver is analogous to that of metals whose properties have been greatly changed by being *alloyed* with small quantities of other metals. Does, then, Mr. Meldola suppose that a silver alloy can be formed by precipitating silver in the presence of another metal from an aqueous solution, or that one can argue from alloys, which are solutions, to molecular compounds or lakes? Moreover, he has overlooked the fact that allotropic silver can be obtained in the absence of any metal with which silver is capable of combining, as in the case of its formation by the action of soda and dextrine. Silver cannot be alloyed with sodium.

Mr. Meldola cites Prange as having shown that allotropic silver obtained with the aid of ferrous citrate contains traces of iron, a fact which was published by me several years earlier, with an analytical determination of the amount of iron found. Mr. Prange repeated and confirmed this fact of the presence of iron (in this particular case), and my other observations generally, and was fully convinced of the existence of both soluble and insoluble allotropic silver. Mr. Meldola's quotation of Mr. Prange would not convey this impression to the reader.

Of the many forms of allotropic silver, two of the best marked are the blue and the yellow.

Blue allotropic silver is formed in many reactions with the aid of many wholly different reagents. To suppose that each of these many substances is capable of uniting in minute quantity with silver to produce in all cases an identical result, the same product with identical color and properties, would be an absurdity.

Gold-colored allotropic silver in thin films is converted by the slightest pressure to normal silver. A glass rod drawn over it with a gentle pressure leaves a gray line behind it of ordinary silver. If the film is then plunged into solution of potassium ferricyanide it becomes red or blue, while the lines traced show by their different reaction that they consist of ordinary silver. Heat, electricity, and contact with strong acids produce a similar change to ordinary gray silver.

These reactions afford the clearest proof that the silver is in an allotropic form. To account for them on suppositions like Mr. Meldola's would involve an exceedingly forced interpretation, such as no one who carefully repeated my work could possibly entertain.

I am, *etc.*,

M. CAREY LEA.

Philadelphia, October 22, 1891.

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