

bring it to a standstill by simply pressing the proper key, thus cutting off the current from the offending train and preventing collision. It is only another means by which the controlling mind is more effectively employed to still further reduce the number of accidents, which are now but one passenger killed to one hundred thousand safely carried.

For the illustrations accompanying this article, the writer is indebted to the Signal Engineer of the Chicago, Milwaukee and St. Paul Railway.

EDUCATION BY CORRESPONDENCE.

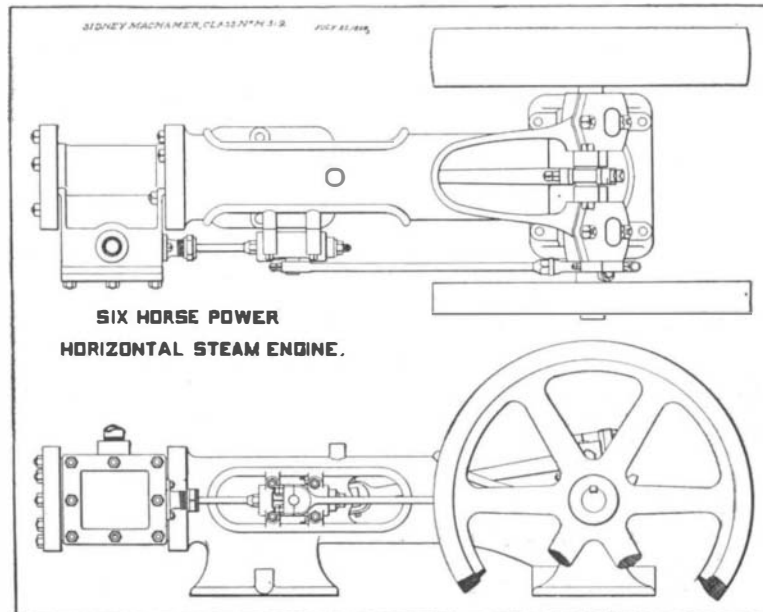
The rapid growth and remarkable popularity of schools of correspondence prove that this new system of education meets a distinct want and has come to stay. Their raison d'être is to be found in the desire of the industrial classes to meet the demand of the technical trades for skilled workmen and foremen, whose education shall include something more than the three "R's" of the district school.

From among the many institutions that are giving instruction by correspondence, we have selected for illustration the International Correspondence Schools, of Scranton, Pa., for the reason that they are the original institution of the kind, and the largest and most representative of the many that are now in more or less successful operation. The Scranton establishment has 130,000 students on its books and is rapidly adding to this enrollment. Starting in 1891 merely as a school of instruction in mining, the scheme of education has widened to include practically the whole field of technical instruction, the intending students having the choice of some sixty separate courses, conducted by a corps of 226 professors and assistants. These figures are surprising and certainly go to prove that instruction by correspondence forms one of the most valuable educational agencies of the day.

Although the roll of the International Correspondence Schools includes the names of many people who are holding responsible positions in the various professions and are already possessed of a liberal education, the chief aim of the schools, as expressed by Mr. T. J. Foster, their founder and present manager, is "to enable people who are engaged in the industrial trades to supply deficiencies in their education due to lack of opportunity or application in their younger days." As thus defined, it is evident that the movement is operating in an entirely new field, being in competition neither with the high school, the technical school, nor the university. There is no question that the ambition of the average American to become a wage-earner frequently leads him to exchange the school for the workshop long before the former has had the necessary time to give him his proper equipment; and while he may for the first few years consider himself financially the gainer, it frequently happens that his advancement in his trade is brought to a full stop by the lack of technical knowledge. It is too late for him to "go to school again," for he can neither afford the expense nor is he willing to give up a position which he may not again be able to secure. The night-school, of course, in many cases affords a partial solution of the difficulty; but there are multitudes of workers for whom these admirable institutions are not available, especially in the thinly-populated and rural districts. Another type that is beginning to avail itself of correspondence instruction is the professional man who wishes to acquaint himself with the principles of a kindred profession, whose work at times overlaps his own. Such a case is that of the architect, who finds that a knowledge of the principles of engineering as applied to the design of framed metal structures is necessary if he is to be full master of his own profession. Many of the students, again, are educated men who wish to study special branches of engineering, or make a thorough review of their former studies; and hence, while the bulk of the students of these schools are drawn from the artisan and farming classes, there is a considerable and increasing number of students of broad education who are taking special courses in the more advanced branches.

The test of eligibility to become a student is that the candidate must be able to read and write English. The schools, to use the language of their prospectus, undertake to teach him "whatever he needs to know." In taking him through a course, the instructor proceeds upon the curious assumption that his pupil knows absolutely nothing about the subject. The assumption is curious and original, but thoroughly philosophical; for, if the student is acquainted with the earlier stages, he passes quickly through them, merely refreshing his memory, while the instructor is certain that in every case the student lays a proper foundation for future work. Starting, then, with the assumption that the student knows nothing of the subject, the schools send him his first and second Instruction and Question Papers.

After studying the first paper, he returns his written answers to the questions asked in the Question Paper to the schools, and proceeds with his second paper. At the schools the answers are corrected in red ink and returned to the student, accompanied by the third Instruction and Question Papers and a letter explaining the errors and corrections in further detail than is possible on the answer sheets themselves. If the student secures ninety per cent on his first paper, it is entered on the books as passed; but if he fails to get this percentage the paper is returned, and he is obliged to review the incorrect portion. This system is followed until the course is completed, when the schools' diploma is granted after a final examination. Although students are not limited as to the time required for the completion of a course, those that meet with difficulties are assigned to "special in-



DRAWING TO SCALE, MADE BY A SIX MONTHS' STUDENT.

structors," who are skilled in dealing with such cases.

One of our illustrations shows a corps of women examiners at work, making preliminary corrections of such errors as occur in arithmetic, spelling, punctuation, etc. The papers are then submitted to the principals and male instructors for final inspection and the correction of such subjects as the women examiners are not qualified to correct, before being returned to the student. The transfer of papers is so arranged that the student has always something to study while the preceding papers are being corrected.

In describing a curriculum that includes no less than sixty separate courses, ranging from Arithmetic to Civil Engineering, it must suffice to take a single subject and let that stand for the whole. One of the most interesting and successful courses is that of Mechanical Drawing. In this, as in all subjects, it is presupposed that the student requires instruction from the ground up. He is furnished at nominal cost with a set of drawing tools, and his first lesson, consisting of exercises in drawing lines, circles, etc., is sent to him. Upon the receipt of his sheet of drawings, corrections with elaborate pencil notes are made, indicating where a full line is ragged, or a dotted line irregular in length or spacing, or defects occur in the lettering. To pre-



RAILROAD INSTRUCTION CAR.

vent mere copying, the instruction charts are printed out of scale, and the students are at all times obliged to draw from scale. One of the last exercises of the course is to draw a complete steam engine from rough pencil sketches of the parts which have the dimensions upon them. The progress in this department is often remarkable, as may be seen from the accompanying drawing, made from rough dimensioned sketches, which was done by a student whose earlier drawings, made only six months before, are extremely crude and rough.

In the chemistry, metal mining and electrical courses, as in that of mechanical drawing, the students can secure from the schools sets of apparatus which are put up specially to meet the requirements of the particular courses. Thus the student in telegraphy is provided with a telegraphic outfit, and the student of chemistry with the necessary reagents and apparatus to cover

the experiments included in the course. The accompanying photograph shows a student in chemistry experimenting.

The courses of study are laid out with a view to giving special training in subjects which in a school or college course merely form incidental features in what is known as a broad education. In the International Correspondence Schools system these courses are divided into two classes, one including a thorough training in the principles of the subject, the other class including courses for those who wish to make a more special and advanced study of the subject. Thus, under the first head may be mentioned the mechanical and electrical engineering courses, and under the second the stationary engineering and locomotive-running courses. The last course includes the study of everything connected with the running of trains, including, besides the locomotive, the air brake, train heating and lighting and the kindred subjects. In connection with this course the schools keep three instruction cars on the road, the first of which is herewith illustrated. These cars are fitted up with complete air brake and other equipments, in the manner adopted by the chief railroads of the country for the instruction of their own employes.

The corrected papers become the property of the student, and if at any time he should be in difficulties, he can turn to his old records and refresh his memory with the corrections made for him during his course. He is also furnished, as he progresses with his work, with a complete duplicate set of all the instruction and question papers, drawing plates and keys, covering the course, which are bound in half leather and form a valuable reference library for use in his future studies, or in connection with his trade or profession.

To the textbook department falls the important work of preparing the instruction and question papers, all of which are the work of the regular professional staff of the establishment. The selection of these gentlemen has been made with a view to giving to

the instruction that practical character which is such a valuable feature of the schools. In every case they have been actively engaged in business, either for themselves or in the employment of well known industrial concerns, and they are thus well qualified by their training to prepare textbooks adapted to the special and practical needs of the student. Most of the faculty are graduates of leading American and European colleges. Among them are to be found former city engineers, ex-chief engineers or ex-chief draftsmen of bridge companies, electrical companies, and general engineering firms, and to this practical experience is to be attributed the clearness, directness, and simplicity which characterize the instruction papers.

Mention of the instruction papers suggests the important matter of illustrating, to which the schools have paid special attention. The excellence of the cuts which appear in the papers is due to the care exercised in the selection of competent draftsmen, and a staff of fifteen (shown in one of the illustrations of the front page) is steadily employed on new work.

It will readily be understood that to carry on a correspondence instruction with over 100,000 students calls for an extensive printing establishment. This work is carried on in five divisions in a separate building. The press rooms, which are located on the first two floors of the building, contain ten cylinder and four job presses. The third floor is occupied by the bindery; and the fourth floor by the book composing room and the proofreaders' room. Work is about to be commenced on a new building, covering over an acre of ground, which will accommodate a printing plant capable of executing all the work of the schools, three-fifths of which at present has to be done in New York and Philadelphia.

From what has been said it will be evident that the new method of instruction as carried out by the Scranton establishment is qualified to rank as one of the most important educational agencies of the day. As long as it is prosecuted along the practical and very thorough lines above described, it cannot fail to exert a helpful and lasting influence upon both the characters and fortunes of thousands of students who devote their leisure hours to its work.

Dwarf Habit of Plants.

M. P. Gauchery has made an exhaustive study of the phenomenon of "nanism" in the vegetable kingdom. His general conclusion is that the peculiarities which distinguish the external form and the internal structure of plants are, like other characters, largely dependent on the environment, and are displayed more strongly in the vegetative than in the reproductive organs. A dwarf plant is not a miniature of the species with all its organs developed in the same proportion as they are in a plant of normal size.—Ann. des Sciences Nat. Bot.

SCIENTIFIC AMERICAN

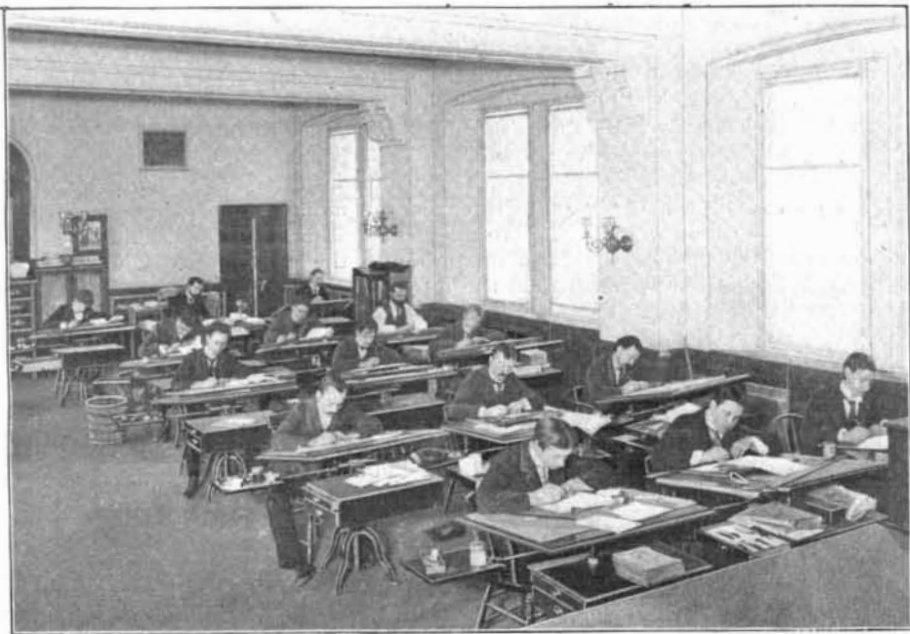
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Illustrating Department.



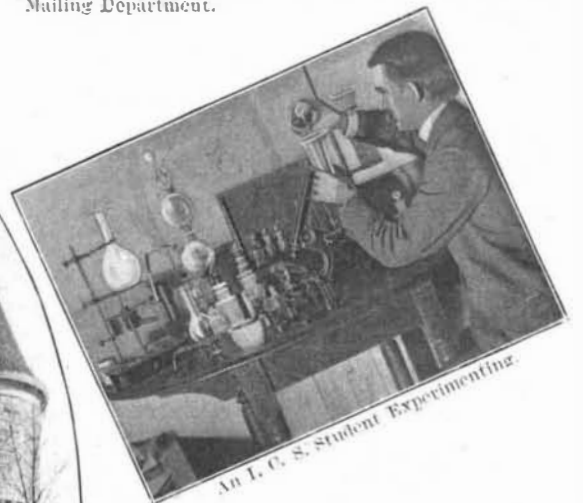
Mailing Department.



An I. C. S. Student Studying.



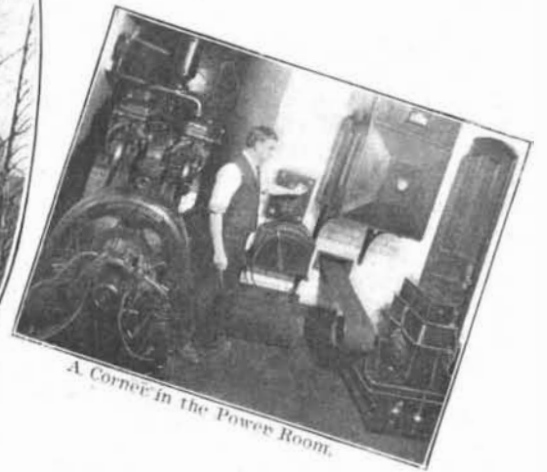
Front View of Main Building.



An I. C. S. Student Experimenting.



An I. C. S. Student "Reciting"



A Corner in the Power Room.



Examiners Correcting Papers.



Textbook Department.

THE CORRESPONDENCE METHOD OF INSTRUCTION.—[See page 374.]

Science Notes.

The condition of the obelisk in Central Park is exciting considerable apprehension, owing to the fact that it has begun to disintegrate. It is very unfortunate that the obelisk was not set up in the court in the Museum building.

Prof. Andrew Gray has been appointed to the chair of Natural Philosophy rendered vacant by the resignation of Lord Kelvin. Prof. Gray was at one time assistant to Sir William Thomson, and is well known from his several treatises on electrical science.

A sanatorium for the treatment of officers and men of the regular army suffering from pulmonary tuberculosis will be established at Fort Bayard, New Mexico, and hereafter transfers of enlisted men can be made to this hospital upon recommendation of the medical officers of the army.

According to *The Pharmaceutical Era*, out of 1,008,500 prescriptions examined, only six per cent were written in the metric system. The information was obtained from druggists in forty-two States and Territories. This is not particularly encouraging, and shows that physicians do not seem to care much about trying the new system.

M. Benard, the French architect, who won the first prize of \$10,000 in the international competition for plans for the University of California, which was established by Mrs. Phoebe A. Hearst, has arrived at New York and will at once proceed to California, where he will place himself in the hands of the trustees of the University for the furtherance of their plans.

Barometric readings reduced to true atmospheric pressure are now required by the Weather Bureau, the approximate corrections for gravity being applied to all barometric readings. This correction applies to all mercurial barometers and is nearly constant at any one station. The corrected reading is a standard measure of atmospheric pressure and can be compared to similar corrected readings made at any place in the world.

One hospital in New York has adopted a camera to record minutely the action of patients in epileptic fits and similar afflictions, and many moving pictures have been taken showing the movements in walking of persons afflicted with locomotor ataxia. They are produced slowly on the screen, so that physicians are enabled to study the symptoms carefully. Moving pictures have been taken in Vienna showing operations being performed by great surgeons.

We have received "The Mussel Fishery and Pearl Button Industry of the Mississippi River," by Hugh M. Smith, forming an extract from the United States Fish Commission Bulletin for 1898. It will be remembered that we published an article upon the subject in the issue of the *SCIENTIFIC AMERICAN* for August 5, 1899, written by Mr. Smith, the author of the present monograph. The subject is one of the greatest possible interest, and Mr. Smith's treatment of it is thoroughly adequate.

Dr. William R. Brooks, director of the Smith Observatory, Geneva, N. Y., has been awarded by the French Academy of Sciences, Paris, the Lalande prize "for his numerous and brilliant astronomical discoveries." The Lalande prize is a gold medal worth 500 francs, or its value in money, as the recipient may select. It was founded in 1802 in honor of Lalande, the learned French astronomer, and is awarded for eminent achievement in astronomical discovery. It is regarded as one of the highest astronomical honors.

Among the foreign exhibits at the Paris Exposition that of the Boers of the Transvaal will be most interesting; 40,000 square feet have been allotted to the Boers. The pastoral life of this people will be shown by a Boer farm, which will portray in a most vivid way the life of the first colonists of the Transvaal. The National Pavilion of the Transvaal will be built in the Dutch style and will display geographical documents, mineral specimens and exhibits showing the methods of instruction in the schools. In the Boer farm will be exhibited the wild animals of the Transvaal. The means and methods of transportation used in the country will also be portrayed. The mining industry will be shown by a five-stamp battery.

It is believed that the recent damage to the great hall of Karnak was caused by a slight shock of earthquake. Eleven columns in all have fallen in the four or five rows north of the axis of the temple, and between this and the wall of Seti I. They all fell in a straight line from east to west, the result being that the westernmost is still partly propped against the pylon of the temple. The ruin is terrible and should be repaired at once if the hypostyle is to be saved. The columns can, of course, be set up again, but the architraves above them are utterly broken and destroyed. M. Legrain, who has been engaged for the last three years in repairing and strengthening the ruins of Karnak, has gone to Upper Egypt to see what can be done toward repairing the damage. The whole building is in such a critical state that it is hoped the Egyptian government will see its way clear to increasing its fund toward the restoration of the temple.

Engineering Notes.

A refrigerating and ice-making plant for the well-known brewing firm of Allsop has been imported from the United States.

An Italian engineering periodical has published a method of sterilizing drinking water by means of peroxide of chlorine, which is so powerful a bactericide that three grammes will sterilize one cubic meter of water at a cost of less than 6½ centimes. This process has yielded satisfactory results at Ostend and elsewhere.

The Italians have added to their system of coast defense batteries of mortars similar to those used in Sandy Hook, which we have already described. Only three, instead of four, mortars are placed in a pit. The indirect plunging fire of the mortars is considered to be of great value in the defense of fixed points against an attack by sea.

The Carnegie Company has gained another point in its long-fought "metal mixer" patent case. The case is now only to be finally reviewed and adjudicated by the Supreme Court of the United States, and upon its decision will depend the validity of the patent covering the metal mixer issued to the late Capt. William R. Jones, assignor to the Carnegie Steel Company, Limited.

The Engineer states that with the electric supply stations in London the boilers and engines in use are divided as follows: Water-tube, 75.5 per cent; marine, 11 per cent; Lancashire, 5.5 per cent; miscellaneous, 8 per cent; while the engines are: High-speed, 62.5 per cent; low-speed vertical, 25 per cent; low-speed horizontal, 6.25 per cent; special, 6.25 per cent. Direct coupling is universal.

Several of the largest abandoned copper mines in eastern Maine will again be operated. The Maine copper mines were in successful operation in 1879 and showed good profits while copper was quoted at 14 cents. The mines could also be operated on a paying basis with copper at 12 cents, but the crash came when the Wisconsin mines put down the price of copper to 8 cents. Now that copper is so high, it will be very profitable to mine it.

It is curious that when China is just on the eve of introducing western methods of engineering she should threaten to demolish the greatest engineering work she possesses; that is to say, the Great Wall, erected 200 years B. C. for the purpose of keeping back the Tartars. It is stated that an American engineer is en route to China in behalf of a Chicago syndicate which is expected to take a share in the contract to be given out by the Chinese government for the demolition of the wall. The Engineer states that one French, two British, and three German firms are also bidding for the work, payment for which is to be in the way of rich concessions.

A central station for the production of acetylene gas is being tested at Tata-Tovaros, Hungary, a city of 12,000 inhabitants. Five miles of pipe covers the city and furnishes gas to 158 street lights and 250 burners in houses. The generating station is located over 600 feet from the nearest house. The gas is produced in four generators by the fall of the carbide into the water. The gas for each group on leaving the generators passes into a cooler and then into a purifier, and finally into two gasometers of 106 cubic feet capacity. The generating plant requires the services of only two men, and the total cost of the installation was \$30,000, of which \$19,000 went for the pipe system.

The new earthquake-resisting, steel-framed palace for the Crown Prince of Japan is now being designed, and the foundations are being laid, with the view of obtaining the structural steel in February. The palace itself will be built of granite and marble around the steel skeleton. It will be 270 x 400 feet and the height will be 60 feet, and will be built in the French Renaissance style. A Chicago engineer has been called upon to design an elaborate heating and ventilating plant. An American ice manufacturing and electric light system will also be added. It is thought that steel construction will revolutionize the building industry in Japan. The new palace will rest on four hundred deeply anchored steel columns embedded in concrete piers. The Carnegie Company will furnish the steel.

Some samples of the cement used in the antique water conduits of Ephesus and Smyrna were recently subjected to chemical analysis, and the various samples were found to be similar in composition. The waterworks from which the samples of cement were taken were constructed from a period several centuries before Christ to three hundred years after. The chief constituent of the samples was calcium carbonate mixed with a small percentage of organic material. This latter was found to consist of a mixture of fatty acids. Experiments were made with a cement such as burned lime and olive or linseed oil, but it was not found to be permanent. On the other hand, a mixture of two-thirds of either slag or lime and one-third olive oil hardened readily and possessed such great endurance that it led to the belief that this was the composition of the ancient cements which were analyzed.

Electrical Notes.

A locomotive in Texas was recently decorated with 100 incandescent lights for use as an excursion locomotive.

A syndicate has been formed to build a single rail high-speed electric railway on the Behr monorail system, between Liverpool and Manchester.

The Third Avenue Railway Company has contracted with a storage battery company for \$400,000 worth of batteries for use in regulating the current.

It is said that successful trials of a telephonic apparatus without wire have been had in Italy. The instruments were installed on moving trains. The details of the experiments and apparatus are very meager.

It is said that the Executive Committee of the Erie Canal Electric Traction Company has adopted the storage battery for use as a motive power, subject, of course, to the approval of the Superintendent of Public Works.

It now appears probable that the Mont Blanc Railway will eventually be built. The line is to be worked electrically, and is to start from Ouches and end at Petits Rochers Rouges. The Arve will be utilized to furnish the necessary power. The line will be 6.83 miles long and there will be twelve stations.

A funicular railway has just been completed up to the Schatzalp, at Davos-Platz. It begins at the rear of the Kurhaus and is about 2,200 feet long. The power employed to propel the cars is electricity, which is generated in the valley by dynamos actuated by gas engines. This is one of the first funiculars in Switzerland to use electricity as a motive power.

At the meeting of the Metropolitan Street Railway Association, President Vreeland shows that out of every 5 cent piece which is collected from fares, the amount obtained by the stockholders is very small. Labor amounts to 0.0195 cent; material, 0.0048½ cent; taxes, 0.0026 ½ cent; interest, 0.0144 cent, making a total of 0.0414 cent, leaving for stockholders 0.0086 cent. In other words, the stockholders of the company get less than ⅙ of one cent out of every fare collected as net profit.

A new species of mountain railroad has been devised in Germany. It consists of an electrically worked rope railway, the railway being in sections, the cars being suspended on rollers. As it is not considered safe to allow a greater distance than 4,000 feet between the supports, intermediate stations are necessary, the passengers changing from the first to the second section and so on until the journey is completed. About seven minutes are occupied in traversing each of the 4,000-foot sections.

At the recent Exposition in Como, the "Voltaic pile" was very much in evidence, not only as an architectural feature of the ill-fated Exposition buildings, but everything in the way of souvenirs was gotten up in the same form. Boxes of chocolate, pepper boxes, almanacs, etc., were all based on this design, and chromo-lithographs and silk handkerchiefs with pictures of Volta were for sale everywhere. These matters all testify to the appreciation of the greatness of this early electrical inventor.

Various methods have been provided for cooling tubes for use in the production of the Roentgen rays. One method is to connect the anti-cathode by an iron rod with a small flask of water at the tube. Another method is to bring the water in direct contact with the anti-cathode; a wide tube of platinum is soldered directly into the glass tube. Its end is cut at an angle suitable for carrying the anti-cathode, which seals the tube hermetically at that end. The other end projects outside the tube, which is bent outward and carries at its extremity a flask of water. This new device has proved of great practical value.

A new telephone transmitter has been devised and is being manufactured in Pennsylvania. It is so constructed that the outer casing and mouthpiece may be removed for the purpose of cleaning without disturbing the diaphragm or its adjustment. This is accomplished by fitting the diaphragm and carbon parts in an inner casing independent of the outer shell. The diaphragm is held in place by a threaded ring which screws on the inner casing. It is, therefore, independent of the adjustment of the mouthpiece or any other condition of the outer casing. The manufacturers adjust the instrument, and no subsequent adjustment is needed.

Germany will make a large display of machinery at the Paris Exposition. Siemens & Halske and Schuckert will each have a dynamo actuated by a 2,000 horse power engine; the Helios Company, of Cologne, will have one of 1,900 horse power installation, and Lahmeyer, Frankfurt-on-the-Main, will have another of 14,000 horse power. The engines for these dynamos will be supplied by Borsig, of Berlin, the Augsburg and Nuremberg Companies. According to Feilden's Magazine, the crane which is to be used for transporting heavy machines in the central gallery will be supplied by Flohr, of Berlin, and will be capable of raising 25 tons to a height of 40 feet.