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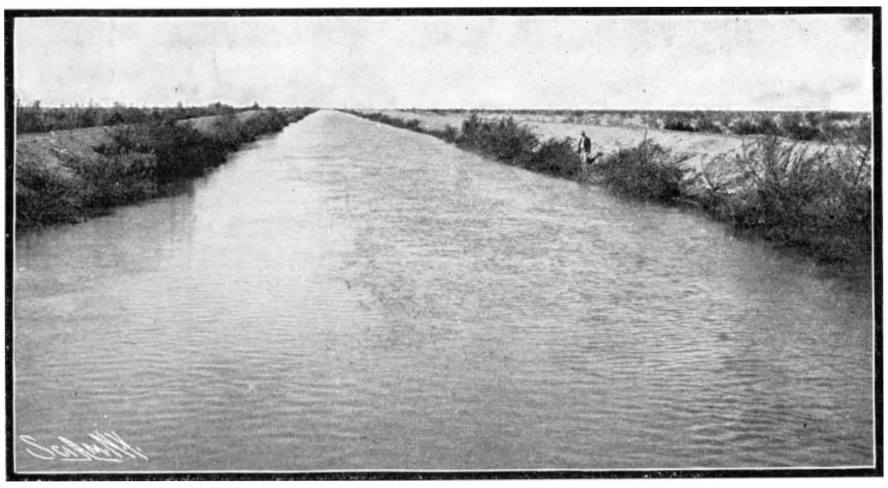

The Main Canal, Showing the Volume of Water that it Supplies.

Droves of Hogs Feeding on Corn Stubble and Young Trees in Reclaimed Desert.

Luxuriant Maize Growing in an Irrigated Field.

Alfalfa Growing on Reclaimed Desert. Stacks of Harvested Crop in the Distance.

The Method of Irrigating the Fields.

WHAT IRRIGATION HAS DONE IN SOUTHERN CALIFORNIA.—[See page 439.]

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NEW YORK, SATURDAY, DECEMBER 17, 1904.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

PANAMA CANAL PROBLEMS.

One by one the various fictions that lingered around the Panama Canal have given way before the thorough investigation of the subject which is now being carried on by the United States government. Most of these errors related to the engineering problems, and they were due to the persistent efforts of the advocates of the rival scheme at Nicaragua to prove that to build a canal at Panama was an engineering impossibility. It took much time and patience to refute these errors and present the true facts to the American public. Now that the work of education is done, and the country is committed to this splendid enterprise, it is a matter of no small satisfaction to this journal to reflect that the Scientific American took an early stand in favor of the Panama route and contributed largely by its text and illustrations to the desired result. To-day, it is well understood that a canal at the Isthmus is not only perfectly feasible, but that its cost, and the period of time in which it can be completed, may be accurately stated. There was one popular misconception, however, containing just enough of truth to make it formidable, which seems to die very hard. We refer to the widespread belief that the climate of Panama is so fatal, that the construction of the canal can only be accomplished at an enormous sacrifice of human life. Popular ideas on this subject are based upon the percentage of deaths that occurred, or are supposed to have occurred, during the construction of the Panama Railroad, and during work on the canal when it was under French control. There can be no doubt that tropical diseases did make serious inroads upon the army of laborers employed at the Isthmus, in the period referred to; for there seems never to have been any serious attempt at sanitation, either in the construction camps or in the towns along the route of the canal and the railroad; but that the mortality was as frightful as stated has always been open to doubt.

One of the first active steps taken when the canal question passed over to American control was to make a thorough investigation of the climate, the diseases, and the local conditions affecting health in the zone of the canal, and to apply the latest ideas both for the prevention and cure of tropical diseases. The work already done has given most excellent results. Both malaria and yellow fever may be said to be to-day practically under control, and these are the two diseases which are most to be dreaded when the great construction camps are assembled and work is in full swing throughout the whole length of the canal. According to Gen. Abbott, whose various articles, published during the past few years, have been a powerful agency in breaking down the tissue of falsehoods that have grown up around Panama, the records of the hospital of the old Panama Canal Company show that the total death rate among the laborers was far less than is commonly supposed, being, in fact, from 44 to 67 per 1,000. This is much below the exaggerated estimates, which have obtained common credence, one of which told of the death of 600 imported Chinamen within a single year, out of one single force of 1,000 that was landed at the Isthmus. It seems, moreover, that the rainfall has been the subject of as gross exaggeration as the diseases. It varies from about 130 inches on the Atlantic to 65 inches on the Pacific, a record that can be duplicated in the United States, where the average rainfall on the Atlantic coast is about 50 inches and the fall on portions of the Pacific coast compares in total precipitation with that at the Atlantic terminus of the canal. Furthermore, it will be news to many residents of our more northerly latitude to learn that the temperature ranges at Panama from 70 deg. to 85 deg. F., and that it is very rarely that the thermometer reaches the high temperature which is experienced when a hot wave passes over the United States. Temperatures of from 90 to 100 degrees are not uncommon during an ordinary summer on our Atlantic seaboard, and consequently it is not surprising to learn that there are natives of the United States in Central America and Panama who have lived in those localities from ten to eighteen years in good health and with complete immunity from local diseases.

BLONDLOT AND PROF. WOOD ON THE N-RAYS.

Those who have followed the controversy which has been waged over the existence and non-existence of the N-rays, will read with interest two articles which, for lack of space, we have been compelled to publish in the current issue of the Supplement. In one article, reprinted from Nature, Prof. Wood advances what are probably the most telling arguments thus far published on the non-existence of the N-rays. In the other article, written at the Editor's request, Prof. Blondlot replies to Prof. Wood, and demonstrates with convincing scientific evidence that the emanations of which he is the discoverer do exist.

Prof. Wood, after a searching investigation of the rays in an unnamed laboratory which is evidently that of Prof. Blondlot, says that he was "not only unable to report a single observation which appeared to indicate the existence of the rays;" but also that he left "with a very firm conviction that the experimenters who have obtained the positive results have been in some way deluded." Passing over Prof. Wood's criticisms of direct visual observation, in which the element of personal skill enters too largely, the most formidable objection which he has raised is the fact that the method of photographing the N-rays was not conducted with the scientific accuracy demanded in a discovery of so problematic a character. A number of photographs were displayed to him which showed the brightening of the image under certain conditions. A plate was exposed in his presence; but the exposures, as Prof. Wood rightly maintains, were made under conditions which admitted of too many sources of error. The brilliancy of the spark throughout the time fluctuated by an amount roughly estimated as 25 per cent, and this alone rendered accurate work impossible. Furthermore, the two images (with N-rays and without) were built of "installment exposures" of five seconds each, the plate-holder being shifted back and forth by hand every five seconds. It was possible that the difference in the brilliancy of the images was due to a cumulative favoring of the exposure of one of the images, quite unconscious, to be sure, but still sufficient to frustrate the purpose in hand.

Since Prof. Wood's visit to the Nancy laboratory, Prof. Blondlot assures the editor of the Scientific American that he has measured the times of exposure with the utmost accuracy by means of an automatic apparatus. To remove all uncertainty, Prof. Blondlot caused the spark, in the absence of N-rays, to act for a somewhat longer period on the plate, so that the exposure under these conditions was one half a second to one and one-half seconds longer than when the N-rays were allowed to exert their influence. The N-rays were produced by a Nernst lamp, between which and the spark 50 centimeters distant were inserted three sheets of aluminium, a sheet of zinc, a spruce plank 2 centimeters thick, a sheet of cardboard, a sheet of paper, and lastly a plano-convex aluminium lens 5 millimeters thick. Despite these obstructions, the N-rays caused a pronounced increase in the photographic effect of the spark. The photographs thus obtained seem to have been made with such scientific care that they may be considered strong evidence of the existence of the N-rays.

Readers are referred to the Supplement for a more detailed account of the investigation conducted by Prof. Wood and the reply of Prof. Blondlot. We have confined this brief *résumé* to the photographic process because upon photography alone can any scientific confirmation of Blondlot's reputed N-rays be based.

THE ELECTRIC SMELTING OF IRON ORE.

In an age like the present, when the electric current is being applied to such a variety of uses in the industrial arts, there is, at the first mention of it, something decidedly attractive in the proposal to use the electric current in the smelting of iron ore. The wide range of industries covered by the electrical furnace, and the vast scale upon which their operations are conducted, lead very naturally to the presumption that the electric furnace may some day displace the huge blast furnace, costly to erect, and costly to operate because of the enormous tonnage of materials that must be handled to produce a given output of pig iron. The persistency with which the problem is attacked by men who are well qualified for the investigation, proves that the end sought after is no mere dream of the enthusiast. Indeed, electric smelting of iron ore is a perfectly feasible process, if we are willing to leave out of consideration the all-important element of cost. In the present state of the art, however, it must be admitted that for the majority of cases the cost is altogether prohibitive.

The subject has recently been made the subject of investigation by an expert commission appointed by the Canadian government, whose study of the subject was directed particularly to the question as it affected the iron-ore deposits of Canada. The commission made a tour of the best-known electric iron-smelting furnaces in Europe, and its findings have been embodied in a report which has recently been issued by the Canadian Department of Mines. Its conclusions are summed up in the statement that pig iron can be produced on a commercial scale, at a price to compete with the blast furnace, only when electric energy is very cheap and fuel very dear. It was found that on the basis assumed in the report, with electrical energy at $10 per electric horse-power year, and with coke at $7 per ton, the cost of production is the same as the cost of producing pig iron in a modern blast furnace. Under ordinary conditions, where blast furnaces are an established industry, electric smelting cannot compete; but in special cases, where ample water power is available and blast-furnace coke cannot be readily obtained, electric smelting may be commercially successful. On the other hand, although the cost of electric ore reduction prevents it from competing with either the Bessemer or the Siemens open-hearth process in the production of the common grades of commercial steel, the process was found to be in successful commercial use in the production of high-grade crucible steel.

Now the report of this commission, outside of having fulfilled the immediate purpose for which it was presented, should serve as a safeguard to the general public against being led into hasty and undigested schemes for the electric smelting of iron ore. The figure of $10 per electric horse-power year can only be realized under very exceptional circumstances, where water is abundant, readily available, and contiguous to large deposits of iron ore. We believe that the lowest figures obtainable at Niagara are from $15 to $20 per horse-power, and here, because of the size of the plant, and the unlimited volume and great head of water available, the conditions are ideal for cheap production. It may be that some of the large plants which, during the past few years, have been hurriedly erected on a scale far beyond the immediate local demand for power, are making contracts at prices that give very little, if any, return on the investment; and great care should be exercised in using such low figures as a basis of indiscriminate estimate of the cost of electric iron-ore reduction.

LAUNCH OF THE ARMORED CRUISER "TENNESSEE."

The armored cruiser "Tennessee," which was successfully launched on December 3 at the Cramps' yard, Philadelphia, is an armored cruiser which, in the great power of its batteries and its very extensive protection by armor, brings the armored cruiser type one step nearer to the battleship. The "Tennessee" is an improved "Pennsylvania"; but the improvements are of such a nature as to render her a far more formidable ship than her prototype. She has the same speed and coal capacity, but her displacement is 1,100 tons greater, and her armament far more powerful. Her main battery consists of four 40-caliber 10-inch guns of the latest naval pattern, these pieces taking the place of the four 8-inch guns in the "Pennsylvania." The 8-inch gun, when firing capped armor-piercing shells, can penetrate 7¼ inches of steel at 5,000 yards; but the 10-inch piece of the "Tennessee" can penetrate 11¾ inches at the same range. The respective weights of the shells are 250 pounds and 500 pounds, and the muzzle velocity is the same; but, whereas the muzzle energy of the 8-inch piece is 13,602 tons, the 10-inch has a muzzle energy of 27,204 foot-tons. The "Tennessee" carries two more 6-inch guns, or sixteen as against fourteen, and five more 3-inch guns than the "Pennsylvania." Another improvement is in the distribution of the armor. The thickness of armor on the main gun turrets has been increased from 6 inches to 9 inches, with 7-inch bases to the turrets, and the side armor above the water-line belt has been extended until it overlaps the barbettes of the main turrets, thus materially strengthening the protection of this important element. The weak point, if it may be called so, in the design, is that the side armor at the water-line has been reduced from 6 to 5 inches. We could wish that the difference of one inch had been on the *plus* rather than on the *minus* side.

With the exception, perhaps, of the new armored cruisers of the "Warrior" class, designed for the British navy, this is the most powerful armored cruiser in existence. The "Warrior," on the same displacement, is to carry six 9.2-inch guns and ten 7.5-inch guns, the side armor being 6 inches in thickness as against 5 inches in the "Tennessee" and the speed 23 knots as against 22 knots. On the other hand, the protection of the main battery in the new English cruiser is inferior, consisting of only 6-inch, as against 9-inch armor.

NEWS ABOUT THE SUBMERGED COAL EXPERIMENTS.

Some time ago we drew attention to the experiments that were being carried out by the British Admiralty with submerged coal. In May, 1903, five crates of coal, each holding two tons, were sunk in a basin at Portsmouth, and a similar quantity was placed at the coaling point on land, in small heaps, covered with tarpaulins. Six months ago some of the submerged coal was raised and burnt, in conjunction with a similar quantity of that which had been kept on land, and the results showed that the submerged coal had greater calorific qualities. Owing to the success of this test, further experiments are to be carried out on the same basis.

" AMERICAN ESTATES AND GARDENS."

Time was, and not so very long ago, when the attempt to produce a work of high quality devoted to American estates and gardens would have been foredoomed to failure for lack of material. A few planters' homes in the South, some fine old Colonial homes in Virginia, a few good Colonial houses in New England, and some scattered dwellings of the older families in the various seaboard States, the latter owing their interest more to historical than architectural considerations—this would have been the unfruitful field from which the materials for the work must have been gathered.

It was otherwise when the historian and the artist joined hands in the production of the lovely volumes on the stately homes of England which have appeared in profusion during the past few years, and are valued not less in America than in the country they portray. There the authors found ready to hand a wealth of material, the product of centuries of growth, and presenting a bewildering variety of architectural style, most of it infinitely grand and beautiful, and all of it enriched with that charm which only the hand of Time can impart.

At the same time the rapid growth in wealth and possessions of the American people during the past quarter of a century has given them the opportunity to express in larger degree that home instinct which is one of the strongest of our national traits; and the result is seen in the rapid growth among us of the house of importance, the stately home which by virtue of its size, dignity, and spacious surroundings is entitled to rank with the historic houses of the older countries. How rapid has been this development, how numerous and truly magnificent are the great houses and estates of America, is but little understood. It is in the belief that the time is ripe for giving this subject systematic and adequate treatment that we have published a work, "American Estates and Gardens," in which for the first time full justice has been done to a neglected feature of our national growth.

In the three hundred and forty pages and two hundred and seventy-five illustrations of this work, will be found portrayed and described practically every notable home and estate in the country; and it includes many lovely and unique places, whose beauties have never before been illustrated, the exterior and interior views being made by special permission for the present work.

In choosing the subjects for illustration, an effort has been made to include as great a variety as possible of styles, and show how admirably some of the foreign methods have been adapted to local climatic and domestic conditions, especially as affected by country life. The list of subjects includes the mansions of New York, Philadelphia, Boston and other leading cities; the "palaces" of Newport; the splendid seaside residences of the Sound, Long Island, and Palm Beach; the great interior landed estates and mansions to be found from Maine to Florida and as far west as California; while in size the houses illustrated range from the stately "Biltmore" to the snug hunting lodge in the Adirondacks or the tasteful studio where the artist makes his summer home.

The work is rich in interior views—a feature which will render it particularly valuable to those who are contemplating the erection of similar homes; for it is freely illustrative of the latest ideas in furnishing and decoration. Moreover, the American of wealth and leisure is an industrious traveler, and many of the owners of these homes are enthusiastic and discriminating collectors of objects of art. This feature has been borne in mind by the illustrator, and interior views have been selected, as far as possible, which included many of the choicest of these art collections.

A great house, like a rare gem, calls for appropriate setting; and much of the beauty of our American homes is due to the great care with which they have been placed with regard to their landscape surroundings, and to the lovely gardens which flank or front them. The work of the landscape gardener in many of the great homes rivals that of the architects, and throughout this superb volume, the garden views will be found to be one of the most attractive features.

Both the letter-press and the engravings (many of the latter in duotone) are samples of the very best work that can be done in the present state of the art, and the whole is printed on heavy plate paper. As this is the standard work on notable estates and gardens in America, and must remain so for many years to come, it should be in the library of every lover of domestic art and architecture.

THE NEW BRITISH PATENT ACT.

Several months ago the British Patent Act was amended and, among other changes in the practice, provision was made for the examination of patent applications to ascertain the novelty of inventions which are made the subjects of applications for patents. Hitherto there has been no examination in the British Patent Office as to the novelty of inventions, the result being that many invalid patents were granted in Great Britain. The knowledge of this law led many irresponsible attorneys, for the fees received, to encourage inventors to file applications for British patents, the grant of which there was no hope of sustaining in the courts. In fact, so many invalid patents were granted by the British Patent Office that every patent in Great Britain was looked at with suspicion, and the uncertainty concerning the validity of the best patents was seldom, in even a measure, cleared away except after laborious and expensive examinations made by solicitors, the public at large not being convinced that the patent, in fact as well as in name, created a monopoly until the patentee successfully contested the question in the courts. This very unsatisfactory condition led to the change in the law, the operation of which, however, was delayed until a trained corps of examiners could be secured to make the examinations and room could be provided in which they might work. Arrangements having now been completed, January 1, 1905, has been set as the time when the new provisions of the law will go into operation.

The examination will not in Great Britain, as in the patent offices of many other countries, attempt to include within its scope all that has been done throughout the industrial world, for it is provided in the new law that the examination will only include British patents, the applications for which were filed within fifty years immediately preceding the filing of the application which is being examined. As the knowledge of an invention outside of Great Britain will not in itself prevent the grant of a valid British patent, the examination in effect is much more complete than would at first appear, and the result will be to add materially to the commercial value of patents and patented inventions.

United States, German, and other inventors in whose home countries thorough examinations are made by the patent offices, will especially benefit by the new law, for they seldom file their applications in Great Britain until, by the actions of the examiners in the home patent office, they know the invention is novel, and they will therefore be able to obtain under the new law the same grant which they might have obtained under the old law, but with the additional value given by the examination. The patent granted under the new law, while substantially the same as that granted under the old provisions, will therefore receive public respect, which under the old provisions was often delayed until after much litigation.

The Patent Office is not authorized to refuse a patent because of lack of novelty, the decision of that question still remaining with the courts, but when an applicant refuses to amend an application to overcome what the examiners believe to be a pertinent reference, the Patent Office is authorized to print the number and date of the reference on the printed copy of the specification, to inform the public where the reference can be found and that certain features of the invention are believed to be anticipated by the examiners in the Patent Office.

The fees under the new law have been increased, but applicants will receive a most satisfactory return for the slight increase in the cost of the British patent.

TO OUR SUBSCRIBERS.

We are nearing the last issue of the year—the fifty-ninth of the Scientific American's life. Since the subscription of many a subscriber will soon expire, it will not be amiss to call attention to the fact that the sending of the paper will be discontinued if the subscription be not renewed. In order to avoid any interruption in the receipt of the paper, subscriptions should be renewed before the publication of the first issue of the new year. To those who are not familiar with the Supplement a word may not be out of place. The Supplement contains articles too long for insertion in the Scientific American, as well as translations from foreign periodicals, the information contained in which would otherwise be inaccessible. By taking the Scientific American and Supplement the subscriber receives the benefit of a reduction in the subscription price.

A new electric furnace method has been invented by M. A. Nodon. The electro-negative metal is fused and used as the cathode in an electric furnace with a non-attackable substance as anode and an electrolyte of a fusible, only slightly volatile, halogen compound of the more electro-positive metal. When a current is passed through, the ionization effected produces a combination of the metals, with liberation of the halogen.

SCIENCE NOTES.

Is it possible to express the pleasantness or unpleasantness of a climate on a scientific scale? asks Knowledge. Capt. W. F. Tyler, F.R.Met.Soc., has attempted to form such a scale. Concluding that the two dominant factors influencing our sensation of comfort are temperature and humidity, he has coined the word "hyther"—apparently from the first syllables of "hygrometer" and "thermometer"—to indicate this joint effect. A perfectly pleasant day is registered 0 on this hyther scale, and an intolerably oppressive one as 10. Capt. Tyler's own observations of "hyther" extend over several years, but in the end of the summer of 1902, he was able to get the co-operation of eleven other observers for the systematic observation of "hyther" throughout the month of August. The results of the comparison showed that most persons would require a considerable amount of practice before their observations could be considered trustworthy, but some approach was made toward the establishment of a definite law connecting the temperature and humidity with the hyther sensation. At the same time there were indications that some other factors, possibly barometric pressure or electric conditions, had an appreciable influence upon the sensation. The subject seems well worth working out on a more extended scale.

When an alkaline solution of gold is treated with different reducing agents, a strongly colored blue or red liquid is obtained which is supposed to contain the gold in a colloidal state. M. Hanriot, of Paris, took up a series of researches upon this question. He had previously shown that the different varieties of colloidal silver formed as many chemically distinct species having different properties, and wished to see whether gold did not act in the same way. Under the name of colloidal gold, Heinrich describes solutions which he obtained by treating chloride of gold with different reducing phenols such as pyrocatechine and hydrochinon. M. Hanriot formed a solution of colloidal gold by dissolving one gramme of chloride of gold in one liter of distilled water. This he boiled with enough carbonate of soda to give a slightly alkaline reaction. He then poured in a 1.1 per cent cold solution of pyrocatechine to the amount of 300 cubic centimeters. This formed a red color which soon changed to violet. Dilute sulphuric acid was added drop by drop until the solution became slightly acid. The liquid turns blue in this case and deposits a blue precipitate at the end of a certain time. After washing, the powder is dissolved in dilute ammonia and again precipitated by sulphuric acid, avoiding excess of the latter. This compound is a violet-blue powder which is very slightly soluble in pure water, but is insoluble in a slight excess of sulphuric or nitric acid or their alkaline salts. On the contrary it dissolves easily in alkalis, especially ammonia or carbonate of soda. The excess of ammonia can be expelled from such solution by boiling, but this does not throw down the gold. Strong acids, however, will cause a precipitate in this case. The latter precipitate is found to be hydrated, and water forms part of its constitution. Thus, when dried at 100 deg. C., it loses its solubility in alkalis. The analysis of the body, dried at 40 deg. C., is as follows: Water (which is expelled at 100 deg.) 2.04 parts; loss at red heat, 6.31; gold, 91.53; SO_3, 0.39. This compound is but little altered by acids. In alkaline solution it soon deposits metallic gold, while the liquid takes a brown color. It seems to contain an organic matter which is not easy to determine. Colloidal gold is not soluble in mercury. When calcined it gives off carbon monoxide and dioxide gases, and hydrogen. A point to be observed is that this body is precipitated from a solution by acids and in this state is insoluble, but is re-dissolved by adding an alkali. It is therefore not to be admitted that the solutions are formed of fine particles of gold which are not agglomerated, seeing that this body keeps its solubility even when in the solid state, as above shown. Besides, it shows acid properties and forms a series of salts with the heavy metals which are either soluble or insoluble, each having individual properties.

The retirement of William K. Jenne, of Wyckoff, Seamans & Benedict, was marked by a complimentary dinner given to him at the Waldorf-Astoria, Monday, November 28, and the tendering of a loving cup.

To Mr. Jenne, more than any one else, is the development of the modern typewriter due. It was in 1873 that the first crude model of the typewriter was taken to the gun works of E. Remington & Sons at Ilion. The development of the invention was placed in charge of Mr. Jenne. In Mr. Jenne's charge, it ever since remained. Through his labors the machine has steadily advanced through all the successive stages of improvement, from the first crude ideas of the inventors to the Remington models of the present day. During this time Mr. Jenne has not only seen the development of the typewriter, to which he devoted the labors of his life, but has also witnessed its progress from an absolutely untried experiment to the necessity it has now become in the world's work.

RADIUM AND RADIO-ACTIVITY.

The popular literature concerning radium and radio-activity is so extensive, confusing, and in many cases misleading, that a succinct account of the whole subject and of the experimental proof of the most important phenomena may be of interest. The emission of Roentgen rays from that part of the glass tube which the impact of cathode rays from within had made fluorescent suggested the thought that Roentgen rays might accompany other cases of fluorescence. Becquerel found, indeed, that the well-known fluorescent uranium compounds emit also invisible rays which have much in common with Roentgen rays, but the same property is shown by non-fluorescent uranium compounds and still more strongly by metallic uranium, so that the invisible rays are not caused by fluorescence. It was soon proved, also, that the Becquerel rays are not identical with those of Roentgen, and it is now known that radio-activity, or the power of emitting Becquerel rays, is possessed by many substances, though by most of them so slightly that exceedingly delicate methods are needed for its detection. Thorium and its compounds are nearly as radio-active as uranium; but by far the most radio-active substances known are radium, polonium, and actinium, recently discovered by the Curies, Bemont, and Debierne. All of these, together with two other strongly radio-active substances, "radio-lead," discovered by Hofmann and Strauss, and "radio-tellurium," discovered by Marckwald, are obtained from pitchblende and other uraniferous ores. Radium is the only one of the five whose elemental character has been established by a distinctive atomic weight and spectrum. It has not been isolated, but its chloride and bromide have been obtained free from salts of other metals. Polonium is closely associated with bismuth, actinium with thorium, radio-lead with lead, and radio-tellurium with tellurium. The elemental character of all four is still in question. Five thousand tons of Joachimsthal pitchblende yield about one gramme—15 grains—of pure radium chloride. Traces of radio-activity are found in air, especially the air of caves and of the ground, in clay soils, water, the gases evolved by certain springs, and in "fango," the mud of a hot spring near Padua. The radio-activity of the last named is less than a thousandth part of that of pitchblende.

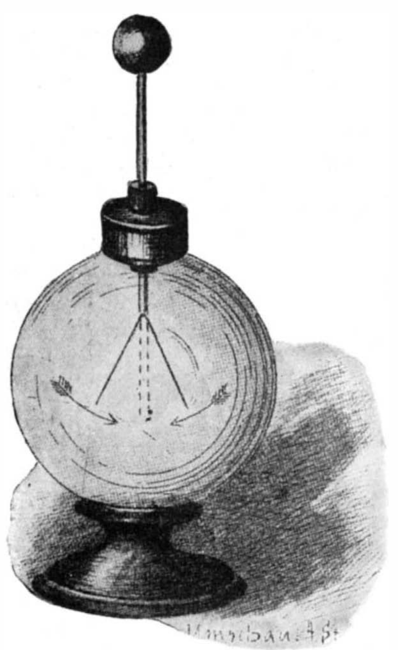


Fig. 1.—Electroscope for Detecting Radio-Activity.

The existence of such infinitesimal proportions of radio-active matter cannot be detected by chemical methods, nor even by the spectroscope, but only by the phosphorescent, fluorescent, photographic, and electrical effect of the radiation itself. If an electroscope (Fig. 1) is charged by touching its knob with a rubbed stick of sealing wax the strips of gold or aluminium leaf, being charged alike, repel each other and diverge, and the angle of divergence forms a measure of the charge. Now, if a radio-active substance is brought near, the charge gradually diminishes and the leaves approach each other.

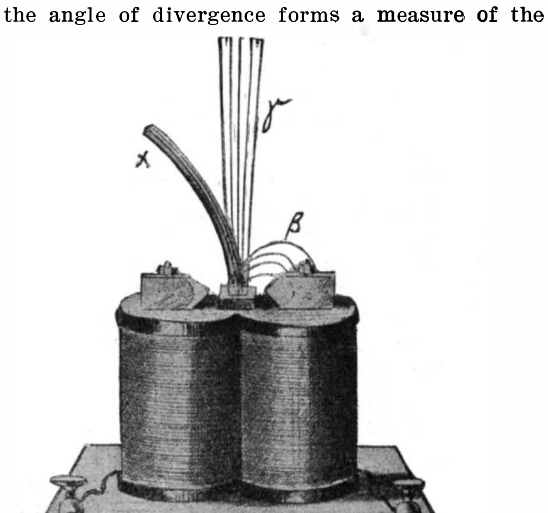


Fig. 2.—Deflection of Radium Rays by an Electro-magnet.

A given electrical charge is dissipated one hundred thousand times as rapidly by pure radium chloride as by metallic uranium, but it does not follow that the total intensity of radiation of the two substances is in the same ratio. For the radiation in question, like that which constitutes light, varies in quality according to its source and it may be analyzed by a magnet as light is analyzed by a prism.

If a little radium chloride is placed in a lead box with a perforated cover between the poles of a powerful electro-magnet (Fig. 2), the entire radiation which escapes goes vertically upward so long as the magnet remains inactive, and its path may be traced by means of photographic plates exposed at different heights. When the current is turned on, however, the beam divides into three, of which one (γ) remains vertical, a second (α) curves slightly to one side, and the third (β) curves much more strongly to the opposite side and is also dispersed or spread out as sunlight is dispersed by a prism.

The α rays suffer great loss by absorption in passing through thin layers of solids and even through air. The γ rays pass with little loss and the heterogeneous β rays are absorbed more or less in proportion to their deviation by the magnet. The α rays constitute almost the entire radiation of polonium and the greater part of that of radium which also emits both β and γ rays, the latter of very small intensity. Thorium, uranium and actinium emit and rays.

The γ rays seem to be identical with Roentgen rays and are therefore the result of wave motion in the ether. The action of the magnet on the α and β rays indicates that these are streams of electrically charged particles. The direction in which such a stream is deflected depends upon the character of the charge (whether positive or negative) and its extent depends on the amount of charge, and the velocity and mass of the particles. From these considerations it has been inferred that the α rays consist of positively charged particles of the size of chemical atoms or molecules moving with not more than one-tenth the speed of light, and that the β rays are composed of very much smaller negatively charged particles, or possibly free "electrons," or atoms of negative electricity, moving almost as swiftly as light. In other words the β rays are identical with the well-known cathode rays emitted by the negative electrode of a Crookes tube, and the α rays are the same as the "canal" rays proceeding from the positive electrode, which were discovered by Goldstein a few years ago. Though the general properties of radium or Becquerel rays resemble those of Roentgen rays, they are not so well suited for making radiographs.

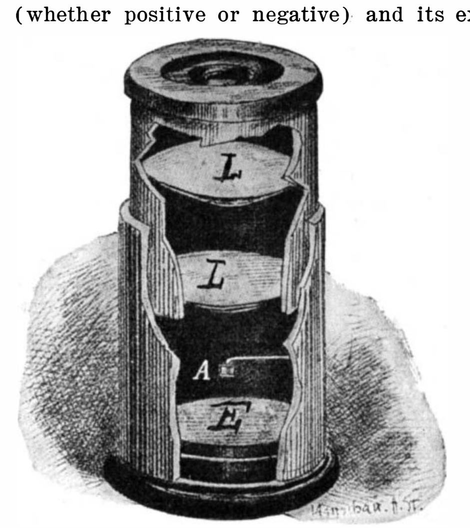


Fig. 3.—Crookes Spinthariscope for the Observation of Radium Rays.

Bodies on which Roentgen rays fall emit secondary rays which are not quite identical with the rays which excite them and these secondary rays may give rise to tertiary rays in like manner. Radium rays have similar effects, and it should be noted that Roentgen rays themselves are the secondaries of the cathode rays. All of these are distinct from the phosphorescence and fluorescence, that is to say, the true light rays, excited by the impact of radium rays, as well as of cathode and Roentgen rays. In the case of radium rays there are some peculiar phenomena which are best observed by means of Crookes spinthariscope (Fig. 3), in which a plate *E*, covered with zinc sulphide, is exposed to the radiation from a bit of radium salt *A*, and observed through lenses *LL*. The plate appears dotted with points of light which flash out and vanish in a manner that suggests bombardment by myriads of tiny projectiles.

The destructive action of Becquerel rays on the skin is far greater than that of Roentgen rays, hence the former seem likely to be more effective in the treatment of lupus and cancer. The Roentgen rays afford no parallel to the paralysis of nerve centers produced by Danysz with radium rays. As a radio-active body emits both positively and negatively charged particles it must acquire an electric charge unless these leave in compensating proportions. As a matter of fact the light negative particles escape far more readily than the heavier positive particles and therefore the substance shows a continually increasing positive charge. Mme. Curie and others have received slight shocks accompanied by sparks on opening sealed glass tubes in which radium bromide had been long kept. The accumulation of the charge is well shown by an apparatus devised by Righi (Fig. 4). A few milligrammes of radium bromide are inclosed in a glass capsule, *B*, to which are attached a thick and a thin strip of aluminium *A*, and the whole is suspended by an insulating rod in an exhausted glass tube through the bottom of which is fused a wire *C* connected to earth. The increasing charge is shown by the gradual divergence of the aluminium foil from the thick strip. When the foil touches the wire the charge escapes to earth and the foil falls to a vertical position but at once begins to diverge again.

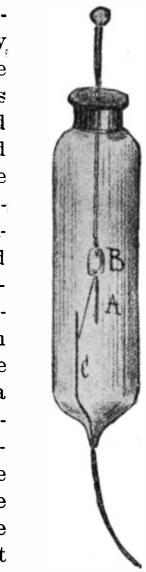


Fig. 4.—Apparatus for Detecting the Spontaneous Electrical Discharges of Radium.

Discharges occur at intervals of a few minutes until the strip is worn out by its ceaseless motion.

Radium and thorium compounds emit also an unquestionably material "emanation" or gas which has been condensed to the liquid form.

Being radio-active, the gas seems to confer the same property, temporarily, on substances to which it clings. According to Giesel, it contains an element related to lanthanum, which he has named emanium, but the investigation is still unfinished.

Others have observed that the emanation gradually changes into helium, a gas long suspected to exist in the sun and recently found on the earth, especially in radio-active minerals and springs. The continuous production of the emanation points to a gradual transformation of the radio-active substance and suggests a cause of the spontaneous evolution of heat also observed in radium. According to the theory of Rutherford and Soddy, indeed, radio-activity is merely a subsidiary [an accompanying] phenomenon of the transformation of unstable into stable forms of matter.—Condensed from Dr. Bernard Dessau, in Die Umschau.

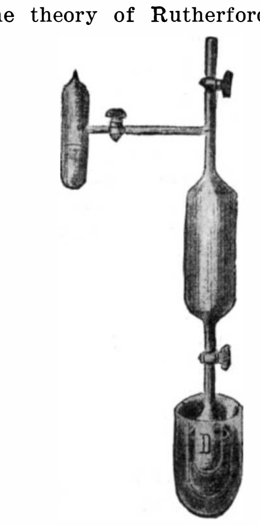


Fig. 5.—Condensation of Radium Emanation by Liquid Air.

An interesting trial was recently made by a German firm to discover whether lighters can be safely employed for the transit of timber from the Norwegian coasts, across the North Sea, to English ports. For the trial a new type of lighter was constructed, with a carrying capacity of 1,200 tons of lumber, which is about four times the carrying capacity of the sailing vessels at present employed in this traffic. Powerful tugs were also built to tow the lighter across the North Sea. The passage of the cargo from Riga to the Tyne occupied eight days, which compares very favorably with the time occupied by the sailing vessels. The success of this experiment opens up new possibilities for the transit of lumber between these two points, since it is much cheaper, owing to the greater tonnage that can be handled on a single journey.

Speaking at the International Geographical Congress on the formation of Niagara Falls and Gorge, Prof. Grove Karl Gilbert, of Brooklyn, prophesied that the Niagara River will probably run dry in 3,500 years, because Lake Erie will find another outlet.

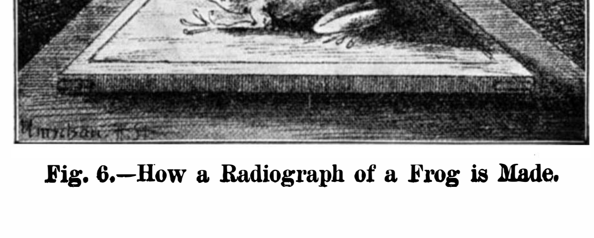


Fig. 6.—How a Radiograph of a Frog is Made.

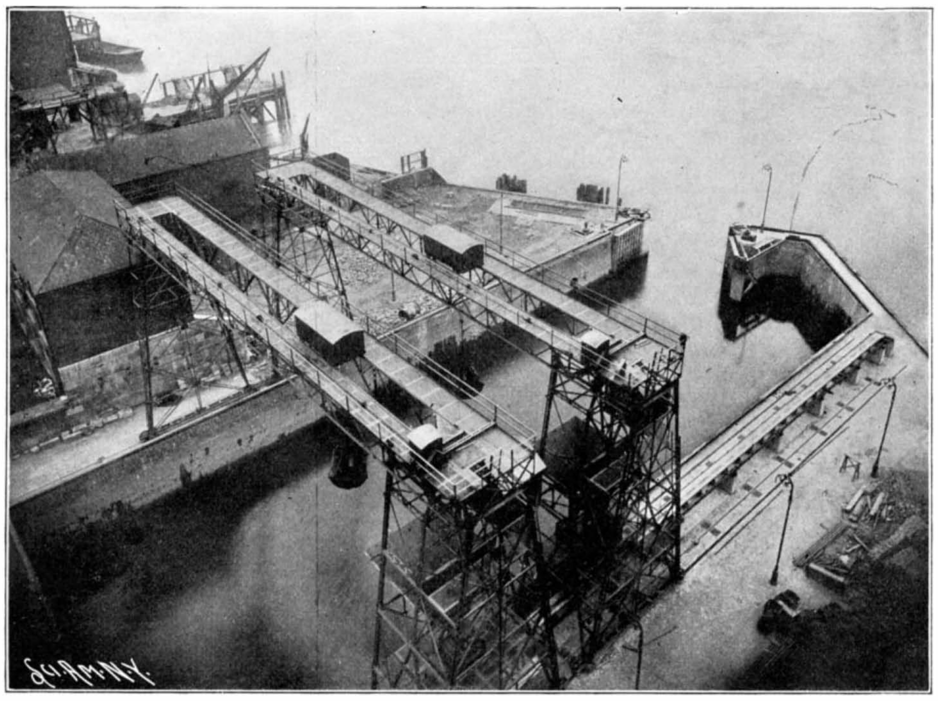
THE GREAT LONDON POWER STATION.

BY HAROLD J. SHEPSTONE.

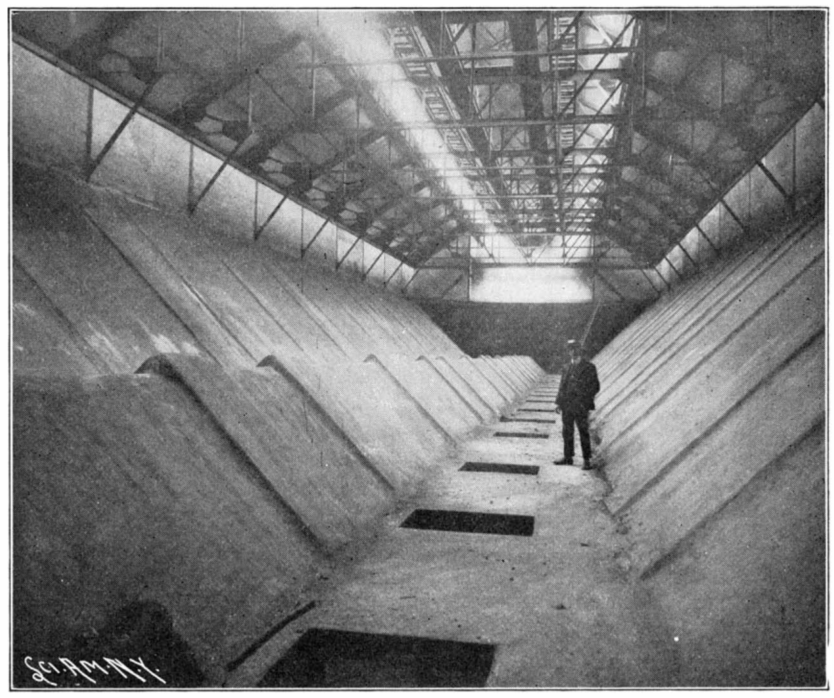
The great generating station at Chelsea, London, which has been built by Mr. Charles T. Yerkes to furnish the necessary power for working the Metropolitan District and other London railroads, has now reached a stage in its erection when a reference to the undertaking cannot fail to be of interest. Its rapid erection, coupled with the fact that several of its engineering features are entirely new, single it out as no ordinary feat in the electrical and engineering world.

The work was started in the autumn of 1902, and although the station will not be completed until the beginning of next year, the amount of work accomplished in the two years that have elapsed is notable. In that comparatively short space of time a vast structure has arisen, twice the size of the one at Niagara, and on ground that had to be cleared of wharves and other obstructions to make room for it. The station is situated in Lots Road, Chelsea, the entire site occupying nearly four acres of land. It boasts of a water frontage on the River Thames and on Chelsea Creek of 1,100 feet, and a frontage on Lots Road of 824 feet. The building proper is rectangular in design, 453 feet long by 175 feet wide, and 145 feet high to the peak of the roof. It has four large brick chimneys, two abreast, each 275 feet high. Being situated close to the river's bank, the huge shafts are very conspicuous, and may be detected for miles around. A popular writer with an imagination, describing the building recently, likened it to an elephant lying on its back with its four legs in the air. A small army of German bricklayers was imported to erect the stacks, and throughout their entire length they were built up from the inside. No exterior scaffolding of any kind was allowed. Each chimney has an internal diameter of nineteen feet. Germans were also largely employed in the erection of the steel work, nearly the whole of the 20,000 tons used in the edifice having been imported from that country.

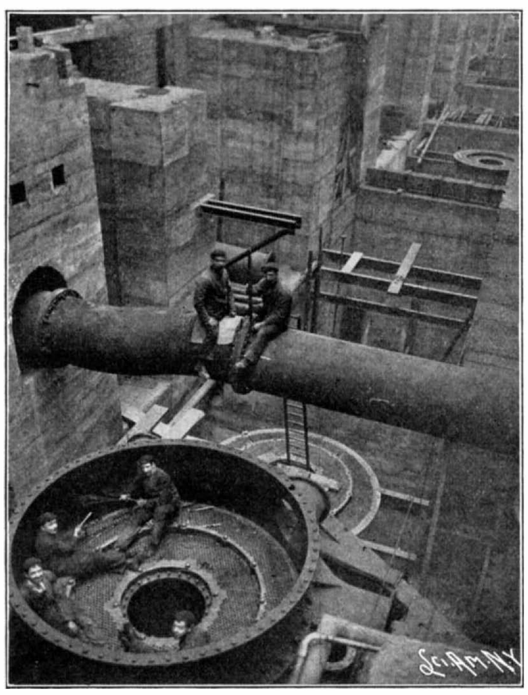
Naturally, great care was taken in securing the foundations. Two hundred and twenty concrete piers were



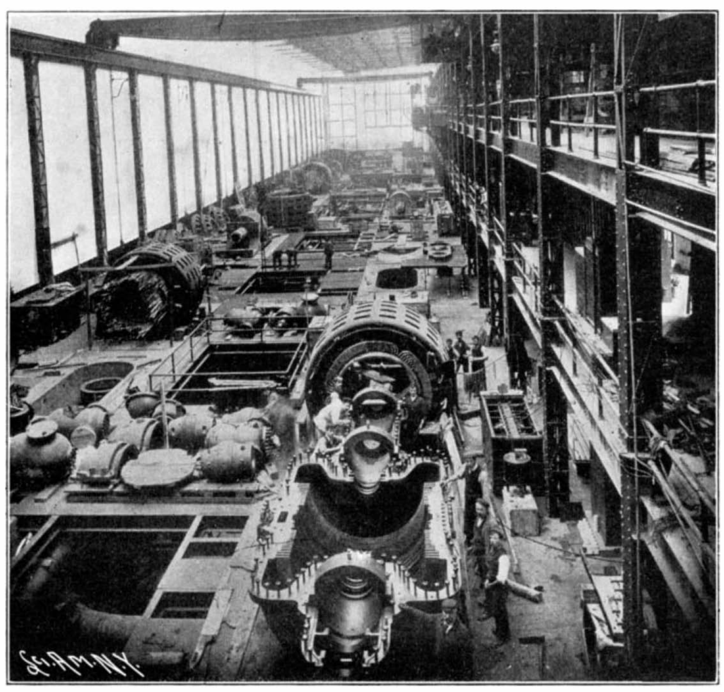
The Wharf, Showing the Traveling Cranes and Conveyors for Handling the Coal.



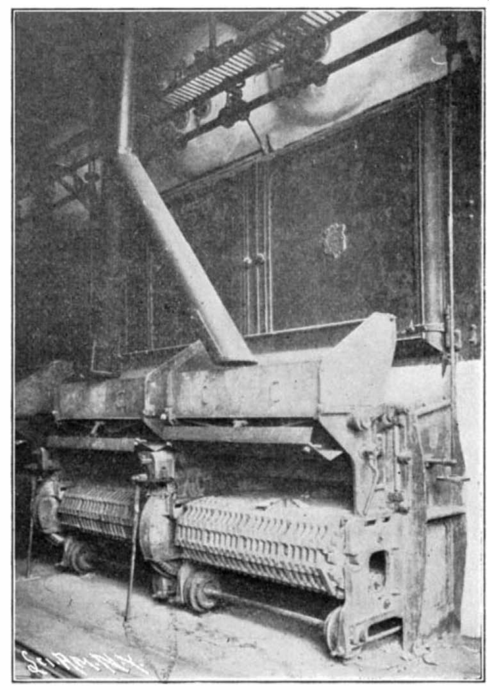
One of the Great Concrete Coal Bunkers. There are Three in all, Having a Total Storage Capacity of 15,000 Tons.



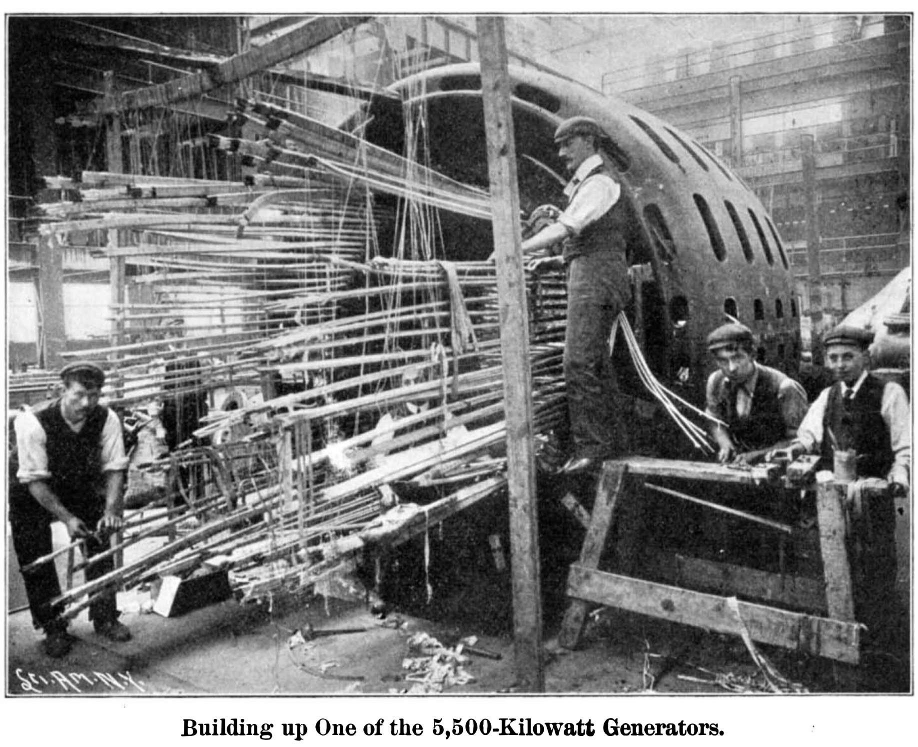
The Condenser Pits in the Engine Room.



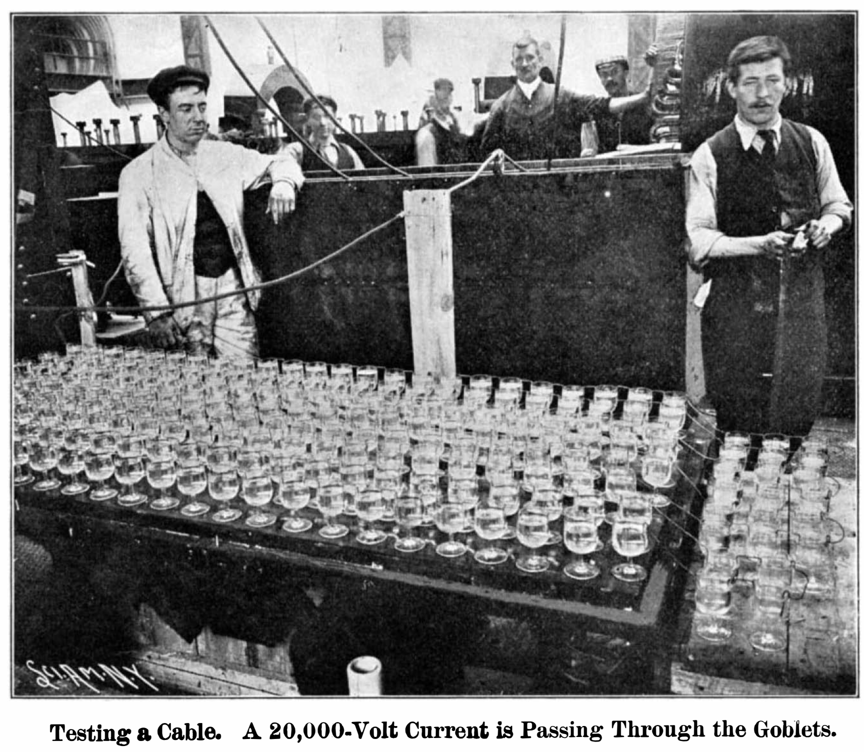
General View of the Interior in Its Present Condition.



The Mechanical Stokers.



Building up One of the 5,500-Kilowatt Generators.



Testing a Cable. A 20,000-Volt Current is Passing Through the Goblets.

THE GREAT LONDON POWER STATION.

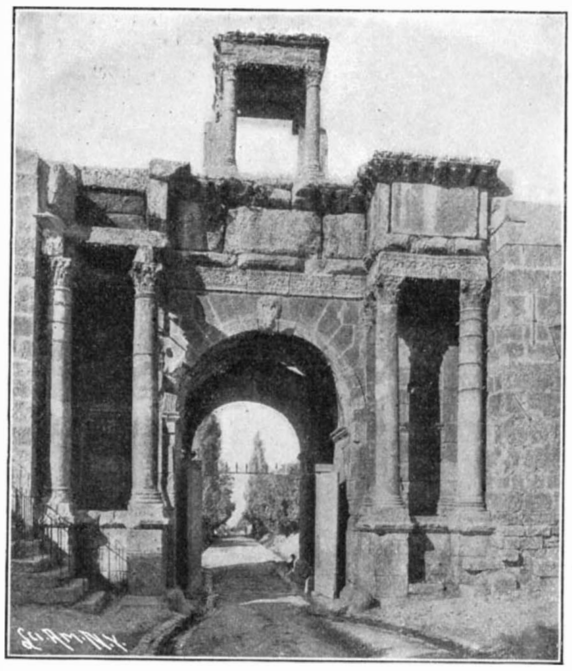
sunk to a depth of 35 feet in the London clay. The foundations for the shafts are 42 feet square, and 35 feet below the ground floor level. Over 2,000 cubic yards of concrete were used in each of these foundations. The steel framework of the building, which has a total weight of 5,800 tons, is self-supporting. After erection, this frame was closed in with bricks and terracotta, the roof and most of the floors being of concrete. No attempt has been made at relief of the exterior of the building in the shape of ornamental decoration, thus giving it the appearance of a huge factory. Adjoining the main building are the offices, which occupy three floors, the lower of which forms the machine shops. This structure measures 81 feet by 25 feet. It is interesting to note here that the capacity of the whole edifice at normal load is 57,000 kilowatts. On this basis the cubic feet per kilowatt (including office building) is 139, and the square feet per kilowatt is 1.36. It will be seen from these figures that considerable economy has been resorted to in the matter of floor space.

The main building is to be divided into two distinct compartments, the near-river half holding some eighty boilers arranged in two tiers. This is regarded as quite a distinct departure so far as Eu is concerned—the erecting of boilers in tiers. The boilers are of the Babcock & Wilcox famous water-tube type. Each boiler has 5,212 square feet of heating surface and 672 square feet of superheating surface. The boilers are already in place. They are piped in groups of eight, each group supplying the steam for one electric generating set and one feed pump, there being no steam connections between the several groups, except that a supplementary header at one end of the building is connected to two groups. This header supplies the exciter engines, or compressors, house pump, etc. Every economical device for reducing labor has been resorted to. Under each boiler there is a chain-grate stoker. They have each 83 feet of surface. Coal is fed automatically direct to the furnaces, and, after being used, passes through chutes to the basement, where it is caught in self-dumping buckets and conveyed to the ash pocket.

The other portion of the building is given over to the turbines and generators, and may therefore be regarded as the most interesting department. One of our photographs depicts the present appearance of this room, from which it will be seen that although a considerable amount of work has been done, there is still much to do. Down the entire length of this room, and along one end, are three galleries given over entirely to the switchboards, from which the currents to all the sub-stations, of which there are twenty-three, are controlled. When all the generating sets have been put in place, it will be a magnificent sight to stand in the galleries and view the machinery below. In all there will be ten sets, each consisting of a Westinghouse steam turbine running at 1,000 revolutions per minute, and a four-pole, three-phase generator, which is wound for a pressure of 11,000 volts at $33\frac{1}{3}$ cycles per second. This is the highest pressure yet employed for traction purposes in Great Britain. The periodicity will be thirty-three and one-third per second. It is interesting to note that the steam turbines, which are the largest ever built, are each—that is to say, nine of them, the tenth being about half the size of the others—29 feet long over all by 14 feet wide and 12 feet high. The normal rating of each generator is 5,500 kilowatts, but they will carry an overload of fifty per cent for two hours at practically the same steam consumption per kilowatt hour. There are also four 125-kilowatt, 125-volt steam-driven exciter sets, which will run at 375 revolutions per minute.

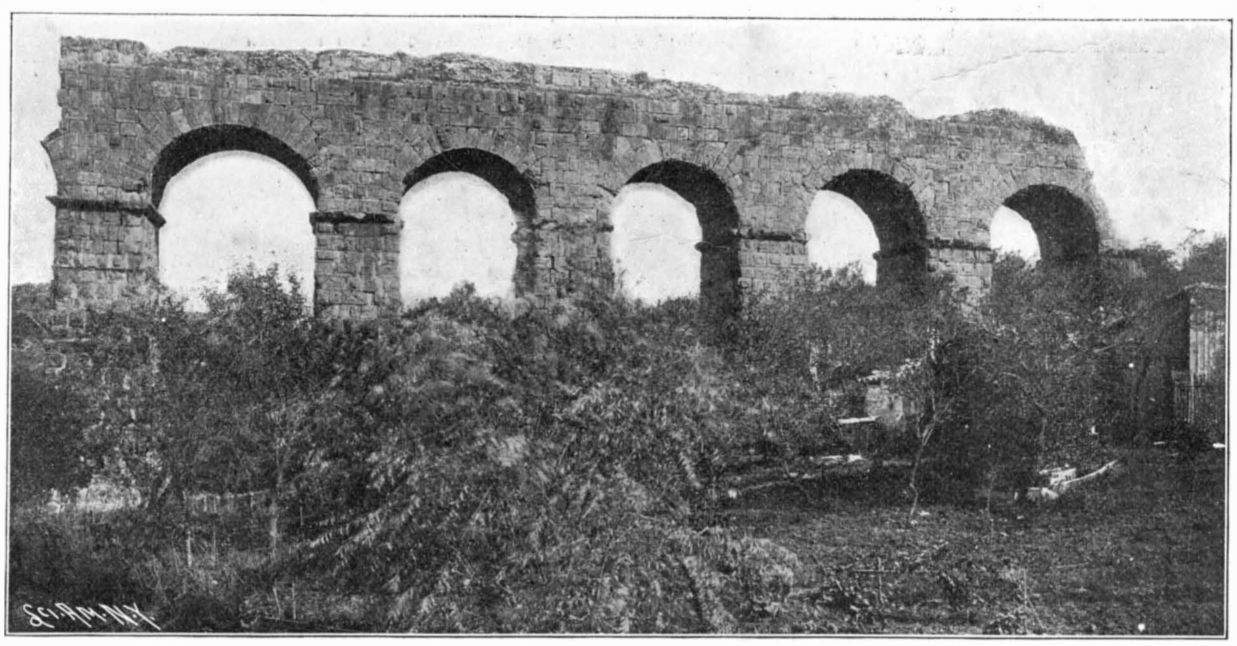
In the pits between the engine foundations are the condensers. They are designed to work on the dry vacuum principle, while all the pumps are electrically driven. They have each 15,000 square feet of cooling surface, and the circulating water will be siphoned from the River Thames through pipes 66 inches in diameter. This water and also that intended for all the other machinery will pass through specially erected filters, to prevent the possibility of the boilers getting "furred." There are no less than four miles of wires about the switchboard. All the high-tension switches are motor-operated, and the feeder system is being erected in duplicate.

Before leaving the engine-room, it may be noted that the turbines are being supplied by the British Westinghouse Company, and are of the Parsons type with Westinghouse modifications. As already stated, the speed will be 1,000 revolutions per minute, while mounted on the same shaft is the three-phase generator of 5,500 kilowatts. In full working order the total horse-power available from this one station, therefore, will be slightly over 80,000 horse-power, or 120,000 horse-power at 50 per cent overload. The boiler-house portion of the station fronts Chelsea Creek, from which barges could unload. This piece of water being the property of a railroad company, a charge of one penny (two cents) a ton is demanded. As the daily coal consumption in full working order would amount to 850 to 900 tons, a penny a ton in the course of a few years would naturally reach a respectable sum. The directors therefore decided to construct a dock of their own. This occupied a considerable time, chiefly on account of the immense amount of blasting which was found necessary. It is now completed, and barges can enter it at any state of the tide. It is spanned by two traveling cranes, each working a one-ton grab. The coal, after being weighed, is dropped through a hopper on to a belt conveyor, and carried up an incline elevator 140 feet in length to the top of the building immediately over the boilers, where the three giant coal bunkers are situated. They have a total capacity of 15,000 tons.



Triumphal Arch of Caracalla.

The power station has been built by the Underground Electric Railways Company, of London, Limited, of which Mr. Charles T. Yerkes is the principal figure. It will supply the necessary power for working the Metropolitan District Railway and the three "tubes" now under construction, namely, the Baker Street and Waterloo, the Charing Cross, Euston and Hampstead, and the Great Northern, Victoria and Brompton lines. The total length of these lines is over sixty miles, the District Railway alone accounting for about forty. The work of laying the two conductor rails for the District system is now practically completed. Electric trains are expected to run over this line early in the coming year. The Baker Street and Waterloo Railway will be ready probably about the same time, but the services of the Chelsea station for the other tube lines of the group will not be required for some time, as the construction of these is not so far advanced. The total cost of the power station has been put down at $7,500,000.



Ruins of the Constantine Aqueduct.

ROMAN REMAINS IN NORTH AFRICA.

ROMAN REMAINS IN NORTH AFRICA.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Among the Roman remains which are to be found in Northern Africa, those of Tebessa are among the most remarkable and best preserved. Tebessa is the *Thevesta* of the Romans, according to different inscriptions which have been found there. It appears for the first time in history in the geography of Ptolemy. Later on, with the title of *Colonia*, it is mentioned in the voyages of Antoninus. It is probable that it commenced to flourish in the time of Vespasian and Titus. It was founded about 71-72 A. D. and perhaps commenced as a Roman camp, at first only temporary, which then became fixed and grew in size. The camp was transformed to a city by the decree of Vespasian and was afterward raised to the rank of a Roman colony. Tebessa reached the height of its prosperity and was a flourishing city at the beginning of the third century under Septimius Severus. The principal monuments, some of which are here illustrated, must be dated from this period. The city no doubt continued to grow until the time of the Vandal invasion, when most of the Roman cities of North Africa were laid waste. Later on, it was raised from its ruins by Solomon, the successor of the general Belisarius, in 543 A. D., as we are told by an inscription found on the Arch of Caracalla. The Arab historians relate that it was taken by Aboud-Yezid in 945, and it has been occupied by the Arabs down to the present time.

The ruins of the city, which are quite extensive, show the traces of these successive occupations. The fortifications which Solomon erected in the midst of the immense ruins of the Roman city are still standing, and serve to inclose the Arab town which now contains but few inhabitants. The walls are from 35 to 50 feet high and are over 6 feet thick in most parts. They are flanked by twelve towers of two stories each. Three gates now lead through the walls. One of these gates dates from the Byzantine epoch, but the most interesting is the gate which is formed by the ancient Triumphal Arch of Caracalla. This is one of the Roman ruins which escaped destruction. The arch, which is shown in one of our engravings, is one of the most important of the Roman remains in Northern Africa. Its mass forms a cube measuring about 35 feet on a side. The arch is of the form known as *quadrifrons*, and each face represents a triumphal arch with one entrance. It seems probable that it was originally placed in an isolated position, and no doubt stood in the middle of a public square. Only one side of the arch is in a good state of preservation. Mounted on the top will be observed a small edicule with four columns. No doubt this was designed to receive a statue which set off the arch and could be seen from a great distance. This structure was built in 211-213 A. D., and was dedicated to Septimius Severus, his wife and his son Caracalla.

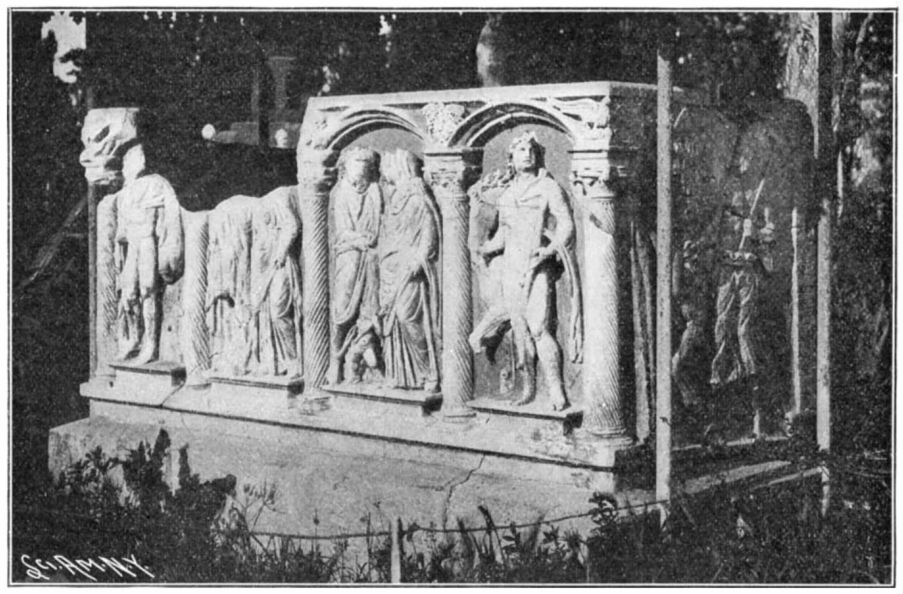
When the city of Tebessa was abandoned by its inhabitants at the end of the fifth century, and was then sacked by the Moors and other roving bands, the monuments suffered greatly, and it is no doubt at this time that the arch was partially demolished. In later times when Solomon re-built the walls of the ancient city, he used the arch to form one corner of his construction. He closed up the openings on two sides by rough masonry and also the upper part of the northern side and transformed it into a city gate and tower. The side which is shown here is sufficiently well preserved to give an idea of its original appearance.

Another remarkable construction which is left from Roman times is the Temple of Minerva. As will be observed in one of the engravings, this handsome structure is in a fairly good state of preservation. The temple has undergone many vicissitudes since the fall of the Roman empire. In more recent times it served as a soap factory, a military bureau, a prison, and then a Catholic church. It is a very fine monument in the Corinthian style, with graceful columns and well-executed reliefs. The edifice measures 35 feet wide by 45 feet long, including the *pronaos* or portico, which is surrounded by six columns, but is not topped by a fronton as in the usual case. It is thought that the latter was originally replaced by a series of statues. The pavement of the temple lies at a height of 26 feet above the original ground level, and is upheld by a three-arched vaulting. A staircase of twenty steps leads up to the portico.

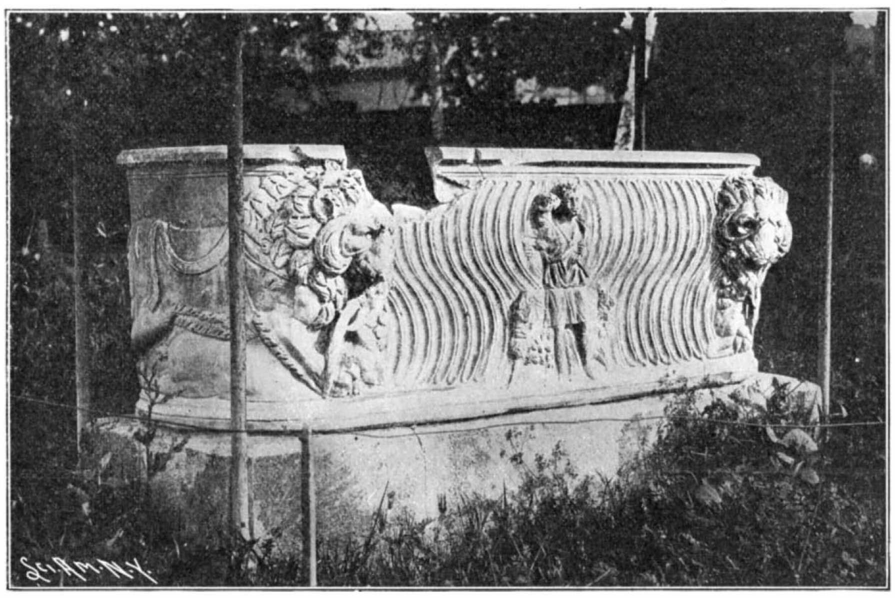
Many Roman remains are found at Constantine, which was fortunate in escaping the fate of Tebessa, and is now one of the large cities of the region. Surrounded as it is on three sides by the deep gorge of the Rhummel, it is a remarkable example of a natural fortress, and must have been the scene of great fighting in the course of history, as we are told that it was besieged and taken as many as eighty times. In the history of Numidia it was known as *Cirta*, and was the refuge of the unfortunate Jugurtha. When taken by the Romans, it was made the capital of Numidia, and its original name of Cirta was retained. After many battles it was partially destroyed, but the Emperor Constantine rebuilt it and gave it his name, which it has since retained. In later times it fell under the domination of the Arabs, then under the Turks, who held it down to the present day. Its siege and conquest by the French troops forms an exciting page in the history of this region. But as this is somewhat outside of our present limits, it may only be mentioned that the Duc de Nemours besieged it in 1837 with 10,000 men, and after a hard struggle succeeded in penetrating into the city. The Turks had taken refuge in the citadel and then tried to escape by means of long ropes which they let down into the gorge. But under the weight of so many bodies, the ropes broke and they all fell down into the abyss and perished. A large number of inscriptions, statues, and other remains have been found at Constantine, and excavations are continually bringing fresh specimens to light. Built into the walls of the Turkish citadel or Kasbah are to be seen upward of twenty Roman inscriptions. The most ancient of these dates from the reign of Alexander Severus. In the way of architecture, one of the most remarkable of the remains is the Roman Aqueduct which lies in the plain at a short distance from the city. This construction goes back to the Emperor Justinian. Five of the arches are still standing. The highest of these is no less than 65 feet above ground.

A fine piece of mosaic was discovered in 1860 by Cherbonneau. It dates from the later empire. In the center is an inscription whose characters leave no doubt as to the epoch. To the right and left of the frame which contains the inscription are two doves. The background is ornamented with flowers. By its characteristics, the mosaic is thought to belong to the early Christian religion, but this is a matter of question. At any rate the inscription might give some color to this supposition, as it reads: JVSTVS SIBI LEX EST, "The just man is his own law." The exterior border of the mosaic measures about 10 feet each way, and the execution is so harmonious that at a little distance it might be taken for a painting.

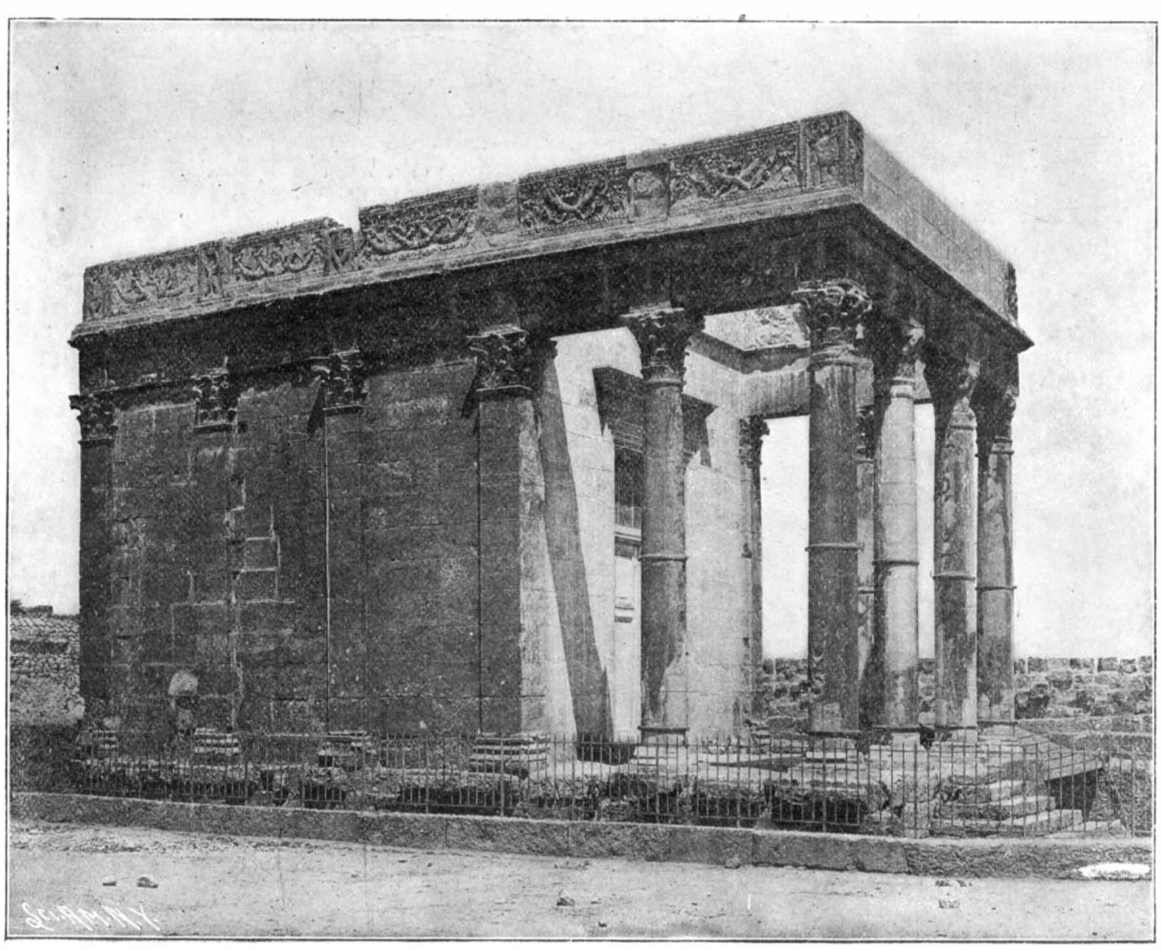
Tipaza is an ancient seaport which still bears the traces of its Roman origin. At present nothing remains of its former prosperity, and it is only a small village lying not far from Algiers. The ancient walls, which were flanked with towers, had a perimeter of 6,500 feet and the sea defended the town on the northern side. Among the principal remains may be mentioned a basilica, which is a rectangle 200 by 100 feet. The seven naves of the edifice were upheld by square pillars. Two sarcophagi of white marble which are now in the garden of M. Tremaux are here illustrated.



The Sarcophagus Discovered at Tipaza.



A Sarcophagus at Tipaza.



The Ruins of the Temple of Minerva.

ROMAN REMAINS IN NORTH AFRICA.

The Great Seal of England.

Something of romance as well as of almost sanctity has always been associated with the Great Seal of England, and many a striking story has been told concerning it. The provision recently, therefore, of the first Great Seal of King Edward VII. is an event of more than merely historic interest; and the Lord Chancellor may assuredly be depended upon to obey both to the letter and in the spirit that statute of Henry VIII. which forbade the "carrying about the Great Seal," inattention to which was largely responsible for costing one of his predecessors the Chancellorship. It was Brougham who in the autumn of 1834 "carried about the Great Seal" to his lasting damage, grave scandal being caused by a report, generally credited at the period, that two good-humoredly mischievous girls had hidden it so effectually at a country house that it could not for a time be found. William IV. was greatly shocked at this, and yet he was the monarch who, in the presence of Brougham himself, had joked over the Great Seal, for, when that Chancellor had intimated that his immediate predecessor, Lyndhurst, claimed half of the old Seal, because he had been Chancellor at the King's accession, the sovereign exclaimed: "Well, then, I will judge between you like Solomon; now do you cry 'heads' or 'tails'?"; and Brougham took the bottom part. This, of course, was not so bad as when James II. flung the Great Seal into the Thames at Lambeth on his flight from London, with the desire to embarrass his triumphant son-in-law, William of Orange; and even this was not so deep a degradation for the Seal as when it was stolen from the house of Lord Chancellor Thurlow and never recovered, though some sort of dignity was attempted to be attached to the theft by the Tory suggestion that it was done by the wicked Whigs for the purposes of party warfare.—Westminster Gazette.

Unsinkable Life-Saving Raft.

An ingenious unsinkable life-saving raft for passenger steamships has been invented by Robert Chambers, of Dumbarton, Scotland, the inventor of the semi-collapsible lifeboat. This raft is built of wood and measures 20 feet long, 6 feet broad by 22 inches deep in center and 14 inches at the edge, tapering at both ends in the whaleboat form. The raft consists of three longitudinal bulkheads, dividing the raft into four longitudinal compartments thwartship. The bulkheads divide into thirty-two air-tight compartments. Sea anchor and hawser are also provided, to prevent the raft from drifting to leeward in a heavy sea. Owing to the small space necessary for the stowage of the raft, several can be safely and easily stowed on top of each other on the vessel's deck. In the event of collision, fire, stranding, or other causes of shipwreck, whereby life is endangered, the raft can be cut adrift at a moment's notice and thrown over the ship's side into the water. It is self-adjusting, and has rowlocks and pulling and steering oars secured in sockets in bottom and top alike. Each raft will carry between forty and fifty people, and the life lines round the edge will support as many as can hang on till rescued. The raft has been severely tested by the Board of Trade, and has been duly passed.

The Bureau of Construction of the Navy Department has asked for bids on twelve sectional wooden wireless telegraph poles for the proposed stations at Key West, San Juan, Panama, and Colon. The poles will be 212 feet high—the tallest ever used in wireless operations in this country—and three will be installed at each of the stations named. It is expected that when equipped with the latest and most efficient wireless receiving apparatus a large field of action for each of the stations will be assured.

THE HIGH-POWERED TRACTION ENGINE AND ITS MANY USES.

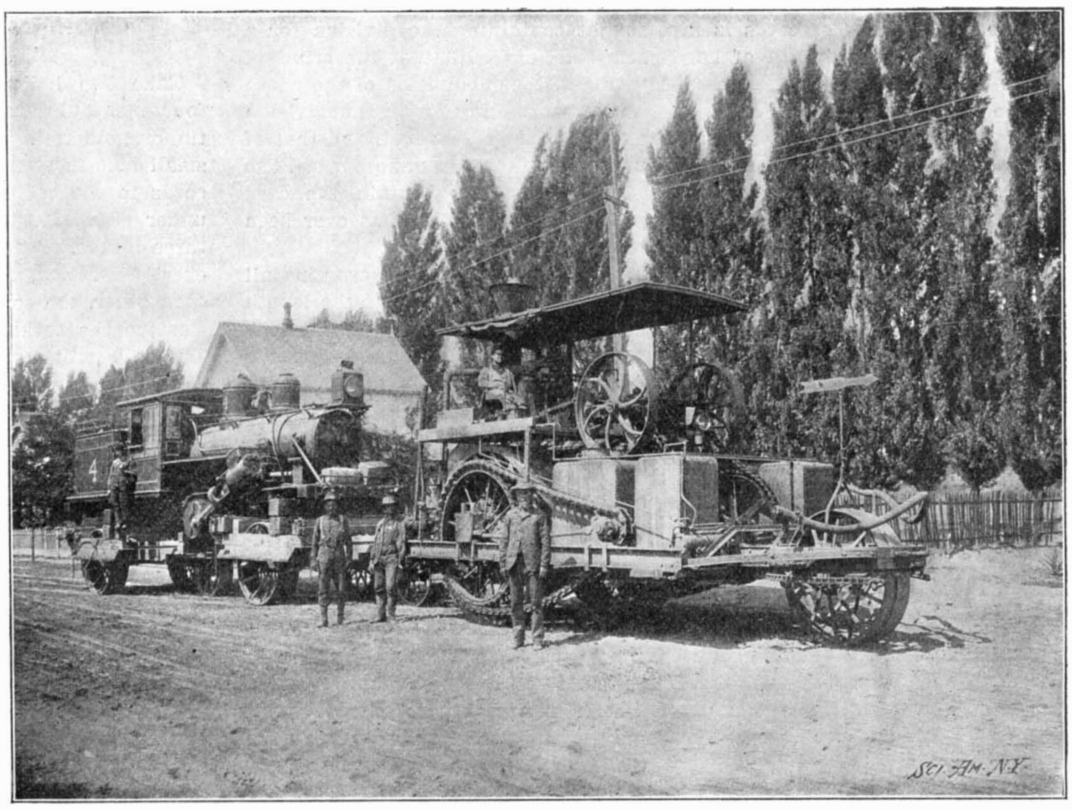
The extensive use of traction engines on the Pacific coast in agriculture and the lumber business attracted attention to their value for other purposes where considerable power is required, and recently they have been employed in California for a variety of novel purposes. In addition to the tractors used for farming and hauling loads of lumber, ranging from 40 to 60 horse-power, another type has been constructed especially for mountain work, such as transporting ore and other freight, in regions where the grades are unusually heavy, or where there are no roads whatever. The ore from the Copper King mines in Fresno County has to be transported a distance of 18 miles to a railway over a very rough country, through the foothills of the Sierra Nevadas. For this service a special tractor has been built, of 100 horse-power. Trains of ore wagons or cars, each having a capacity of 22½ tons, are made up, with one tractor to every two cars, and this method has been substituted for animal power. The freight can be carried more economically and in less time. The engines used are similar in their principal features to those used in the forests, but are more heavily built. They are among the largest of the kind which have ever yet been constructed, and are known as the Best type.

In addition to hauling logs and lumber to the mill or railway station, the tractors are also used for loading purposes. Where logs are to be transported, they are generally piled upon trucks specially made for the purpose. The truck is hauled to the place where the logs are waiting transportation, and skids or stout wooden posts are laid against the side of the truck, forming an inclined platform. Around the log to be loaded is fastened a chain or rope for a grip, which ends in a hook or link. To it is attached a wire rope fastened to the tractor. The engine is started, and the log pulled up the skids and onto the truck. Usually the trucks are large enough to hold two or three logs abreast. When the first tier is in position, it is chained to the body of the truck, then the skids are extended from the top of the tier to the ground, and another layer pulled into position in the same manner. In this way the truck can be loaded with three and sometimes four tiers—an operation which would be very difficult with the ordinary donkey engine, or by the use of animals.

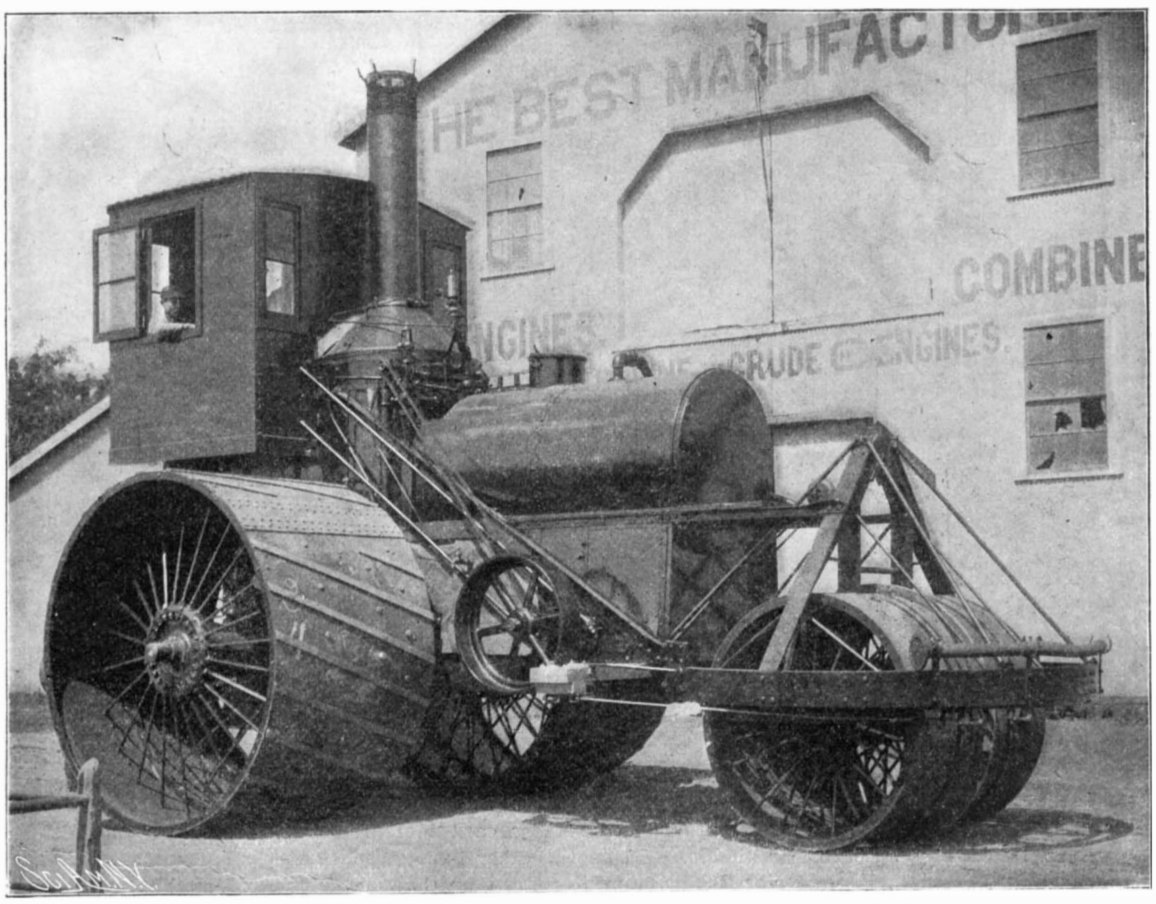
A somewhat novel use of the motor is the moving of dwellings and other buildings from place to place. As a substitute for horses they have been found very successful, as less apparatus is required, and the power can be applied much more easily. In the instance illustrated two 60-horse-power tractors of the Holt type were used for the principal motive power, being connected by cables with the building, which was shored up and placed upon small trucks. As will be noted, they were placed in tandem, while a small tractor was also utilized for hauling purposes, as well as to assist in keeping the building moving in a straight line. The house illustrated was moved over a mile, part of the way being across a field; but frequently buildings are pulled eight and ten miles by this method.

Another illustration of the curious freight which is sometimes transported by this means, may be given. A lumber company decided to build a logging railroad a few miles long between a timber tract which it owned and its mill. The nearest railway station for the delivery of the locomotives, cars, and rails was several miles distant from the tract, and the question arose as to the best method of transporting this material. The company decided to employ a tractor for this purpose, and after the railroad had been completed, all the cars and even the locomotives to be used upon it were drawn across country by this means.

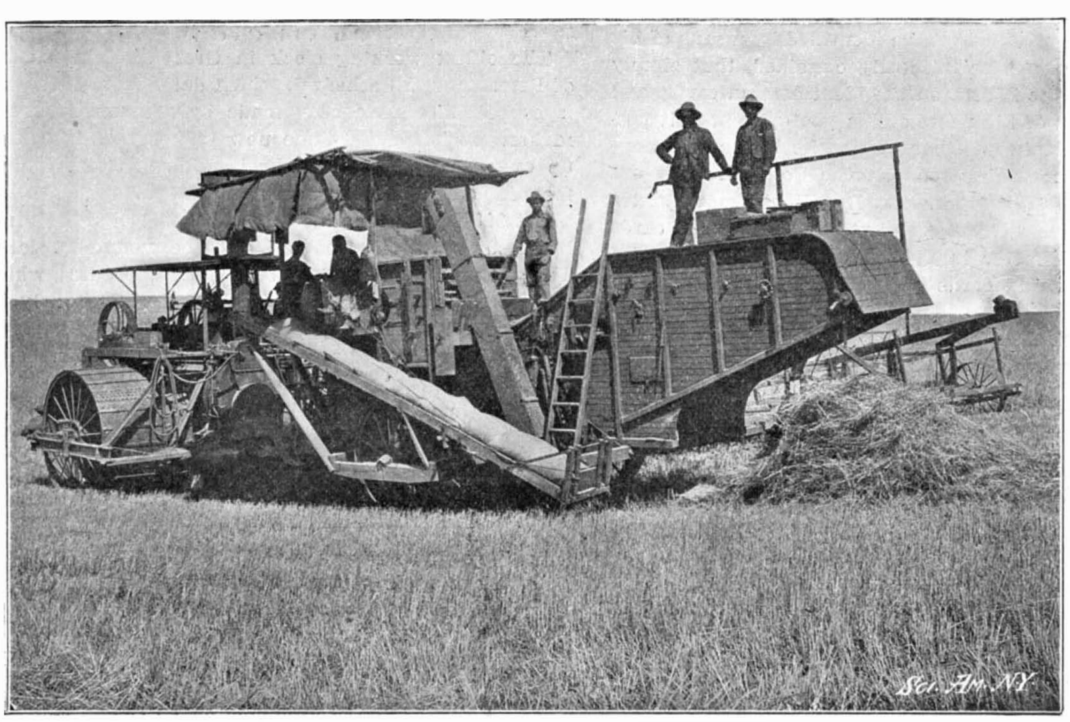
The tractor was utilized in another novel manner in San Francisco recently. It was necessary to replace one of the cables used in a car line upon several of the streets, which have



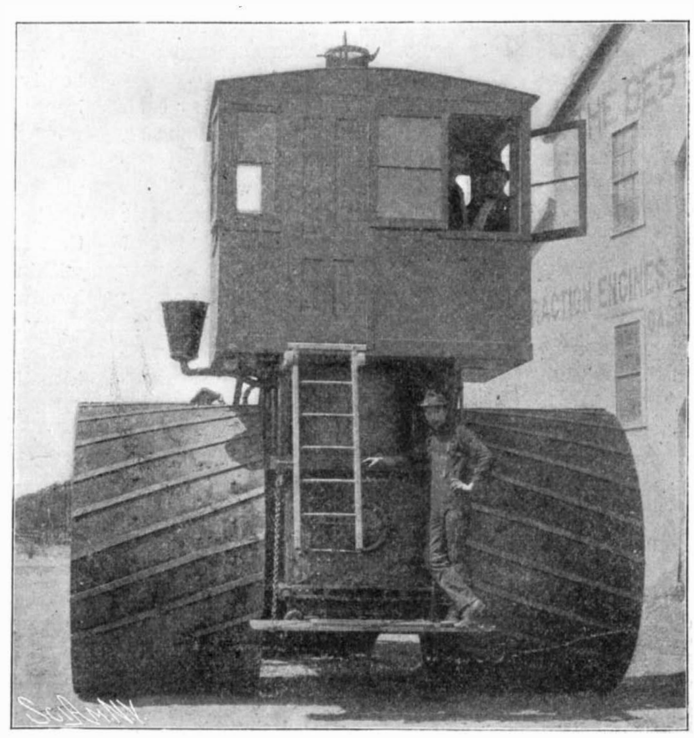
The Tractor Hauling a Locomotive.



A 50-Horse-Power Traction Engine. Driving Wheels, 8 Feet in Diameter and 5 Feet in Width.



The Tractor at Work in the Harvest Field.

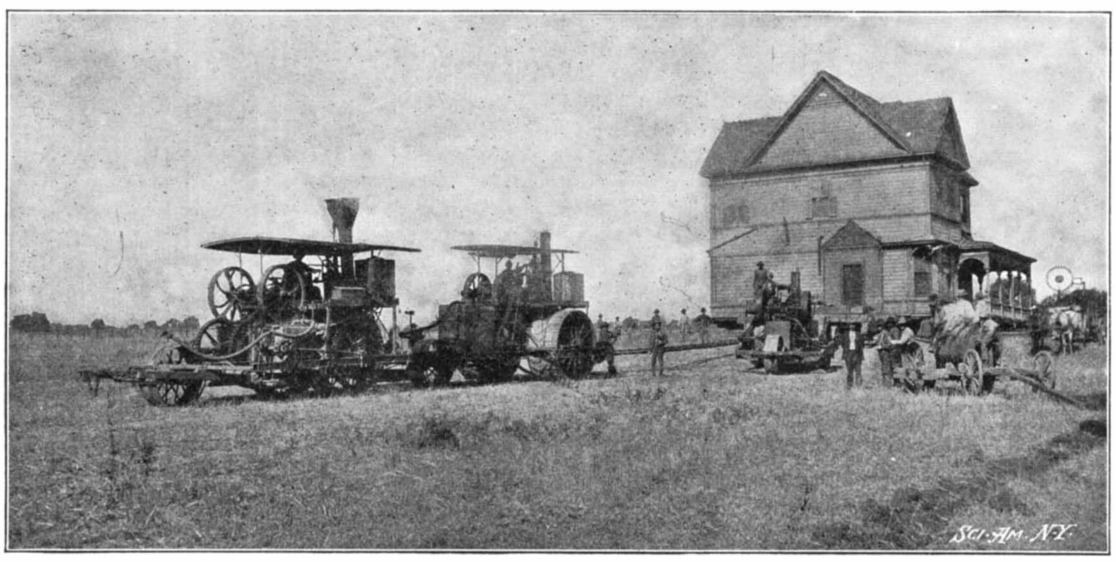


Rear View of the Traction Engine.

THE HIGH-POWERED TRACTION ENGINE AND ITS MANY USES.

very steep grades. A strike among the teamsters made it impossible for the street railway company to secure enough horses to haul the cable to the power house, from which it was to be run through the slot. It was decided to use the tractor, but none could be secured in the city. A telegram was sent to Stockton, which is nearly one hundred miles distant, and one of the largest motors "fired up," and started for San Francisco over the highways. It arrived about twenty-four hours later, and was immediately taken to the wharf, where the cable reel had been placed upon a truck. It was coupled to the truck, and the tractor started for the power house, several miles distant. The route included a climb up a hill on which the grade is over ten per cent, but the load was taken to the top without difficulty, and in two hours from the time the start was made the cable was being unwound.

In addition to plowing, cultivating, and operating the harvester in the grain field, the farm tractor is now extensively used in operating thrashers. Its power is employed to haul the thrashing machines into the field. Then the thrasher is belted to the flywheel of the tractor, and it is used as a stationary engine, although but a small part of its power is required. This type of tractor is provided with a spark arrester of wire, which surrounds the smokestack.



Moving a House in California.

THE HIGH-POWERED TRACTION ENGINE AND ITS MANY USES.

THE BERTILLON IDENTIFICATION SYSTEM.

(*Continued from page* 432.)

bow to the extremity of the middle finger, the forearm being bent at an acute angle with the arm, and the hand extended flat on a table with the nails upward. A specially-constructed table is naturally used—a table rather high and narrow, with trestle-formed supports.

These measurements must be taken accurately. In the Police Department of New York a criminal is measured and photographed in about ten minutes.

As we have already stated, peculiar markings and morphological characteristics are also noted. The color of the aureola and periphery of the eyes is ascertained, together with other peculiarities. The form of the nose is observed—whether the bridge be curved, straight, or convex, whether the base is elevated, horizontal, or depressed. The size of the ear, whether it be large or small, is determined, and also the formation of the lobe.

Characteristics of the teeth, such as their number, whether they have been filled, whether any are broken, are set down. The inclination of the forehead and of the chin is also observed.

The measurements taken must now be classified. This is done by means of cards each 5⅝ inches wide and 6¾ inches high. As the measurer calls out the figures which he reads from the instruments, an assistant jots them down upon an identification card. Assuming that there are sixty thousand of these cards, the first step is to distribute them according to length of head into three primary divisions—"short," "medium," and "long." This classification does not depend upon any personal discretion, but is sharply defined by figures. The medium length of the head is considered to vary from 185 to 190 millimeters. All above this are considered long; all below, short.

We have now three classes of heads, numbering each twenty thousand. Each of these single classes is again subdivided, this time into three groups based on the width of the head, for the reason that the width varies independently of the length, and for the reason that it is impossible to determine from the knowledge of the length of a head what its width may be. The new subdivisions, nine in number, are made up of narrow widths, medium widths, and broad widths. Each of these nine subdivisions numbers approximately 6,666, which is again divided into three groups, according to the length of the middle finger, thus making a total of twenty-seven subdivisions. A fourth subdivision is made on the basis of the length of the foot, which again subdivides each group obtained into three, each containing about 251 groups. Next come three subdivisions based on the length of the forearm, which reduces the preceding number to less than eighty-four. The variations of height divide each of these last lots into three of about twenty-eight each, which are evenly distributed, still on the same principle, into classes by means of the variations of the length of the little finger, and into classes according to the color of the eye. This last group, depending upon the color of the eye, is again arranged according to the increasing size of the ear. In this manner it is possible to arrange a collection of sixty thousand cards into groups of less than a dozen each.

Assuming that the cards are thus classified, how are they used in identifying a criminal? The subject is first measured in the manner which we have already described. Turning to the card catalogue, the group of cards is first sought containing the division for a length of head corresponding to that of the criminal just measured, stopping at the subdivision of the width of his head, and afterward seeking for the subdivision of his middle finger, then that of his foot, and that of his forearm. By one elimination after another, a little group is reached which ought to contain the card sought for, if the criminal in question has ever been arrested before and measured.

As a general rule, it is unnecessary to examine all measurements. It is found in practice that the length and width of the head are in most cases quite sufficient to identify a criminal, for the other measurements conform most admirably to his. By thus placing at the beginning those measurements which have the greatest identifying value, the work of finding a card is considerably facilitated.

It should not be supposed that the measurements of the criminal will conform exactly with the measurements on his identifying card. It is very rarely, indeed, that several measurements of the same subject, taken in rapid succession, will agree exactly. It is difficult, of course, to keep within the proper limits; but then in a system in which so fine a subdivision as the millimeter is used, it is but natural that slight variations occur. It is almost impossible to obtain twice over the same set of figures for the height, the trunk, and the width of the ear. A maximum of negligible error is therefore allowed. In the case of the height, this error is placed at 30 millimeters; of the length and width of the head, at 2 millimeters; of the length of the left foot, at 6 millimeters. Thus, if a criminal who is to be identified has a height of 7 millimeters greater or less than that called for by a certain card, it is absolutely certain that he is the same person, provided the other card measurements conform with his. If, on the other hand, his height is greater or less by 30 millimeters than that called for by the card most closely approximating to his anthropological measurements, it is reasonably certain that he has never before been measured. Such is the precision with which a criminal can be identified by means of his bodily proportions scientifically classified, that simply by means of the figures on the identification cards, and not by means of his name or his photograph, is it possible to ascertain whether or not he has ever before visited the measuring room of the Police Department of the city of New York. Dr. Bertillon himself states that it is impossible to find two exact duplicate cards within a millimeter in the anthropometrical file of a hundred thousand cards in the Parisian Prefecture of Police.

The descriptive marks which are noted upon the identification card serve simply as an aid to the figures. Exclusive reliance is not placed upon them by any means, because it is possible for blemishes in the skin to be removed, because the color of the hair changes with age, and that of the eye as well. The shape of the nose, the ear, and the inclination of the forehead and chin, however, are more trustworthy data. Dr. Bertillon has stated the rule of applying these distinctive marks as a means of identification as follows: All the marks indicated on an old card should be still recognized on the subject if this card really applies to him, but on the other hand, it is not necessary that all marks on the present subject should appear without omission on the old card.

The scientific accuracy of the Bertillon system of identifying criminals is now beyond question. What was previously guesswork in many cases has now given place to absolute certainty. A criminal over twenty-two years of age who has once been measured must be identified if he is ever arrested, convicted, and measured again.

Substitution of Electricity for Matter.

BY EDGAR L. LARKIN.

Take two hollow spheres of wood, each three or four inches in diameter. Cover their surfaces with tin or gold foil. Fill both with fine shot through a small hole in each. Cork, invert, and suspend by silk cords to the ceiling. The apertures will be in their under side. Let the distance between them be, say three inches. A force, or activity named gravity, will exert attraction, and they will draw slightly nearer each other, the cords being drawn out of the vertical. Remove the corks, and allow all the shot to escape. The balls will separate until the strings above are in direction of a plumb line again. Now, charge the metallic films on the globes with unlike static electricity, and they will move toward each other as before. And the charge can be of such intensity that it will attract with the same force as the gravity inherent in the shot. Conceive the spheres to be in an absolute vacuum, so that no trace of electricity will leave the surfaces of the metals. Now imagine that all the wood could be removed without disturbing the coatings. The balls will still attract. And let the metal all be removed from the interior surfaces, out to an external layer whose thickness is the diameter of a Thomsonian corpuscle. Then the electricity, ever moving outward, as layer after layer of corpuscles are removed from the inside, would reside on the extreme external surfaces of the corpuscular films. Attraction would be the same as in the outset. The films might weigh the one-quadrillionth of a gramme. Assume that they would; for corpuscles are of the one-thousandth part of the mass of a hydrogen atom. No mind is able to conceive how thin the layer is when only one corpuscle deep.

Next contract the shell to one-half its original diameter. Its surface will be reduced to one-fourth; but the thickness of the film is four layers. The three interior layers can be dispensed with. The electricity will move to the external layer, and its density will be doubled; but attraction between the globes, mere shells of corpuscles, will be the same as the first, filled with shot. Continue the shrinking; then for each reduction of the radius to one-half, three-fourths of the corpuscles may be cast aside. How far this process could go is unknown; but it is reasonable to believe that it could be carried out theoretically until matter almost entirely disappears. Still attraction is not affected. Of course, it is not known to what density electricity can be forced in a perfect vacuum, nor whether attraction is able to act in the entire absence of matter between the spheres. But it now appears that electricity and gravity are either identical or very closely related.

An Old Clock.

The oldest working clock in Great Britain is that of Peterborough Cathedral, which dates from 1320, and is conceded to have been made by a monastic clock-maker. It is the only one now known that is wound up over an old wooden wheel. This is some twelve feet in circumference, carrying a galvanized cable about 300 feet in length, with a leaden weight of three hundredweight. The cable has to be wound up daily. The gong is the great tenor bell of the Cathedral, which weighs 32 hundredweight, and it is struck hourly by an 80-pound hammer. The gong and striking parts of the clock are some yards apart, communication being by a slender wire. The clock is not fitted with a dial, but the time is indicated on the main wheel of the escapement, which goes round once in two hours. This clock is of most primitive design, more so than the famous one made for Charles V. of France by Henry de Nick.

In the new coal bunker at the New York navy yard precautions against spontaneous combustion have been taken. Each bin is provided with two galvanized iron pipes 4 inches in diameter, 20 feet long, which are so hung that a thermostat may be moved through the entire depth of coal. Each thermostat is connected with a suitably placed annunciator, so that a constant watch can be kept on the temperature of the stored coal.

PHOTOGRAPHY OF THE INTERIOR OF THE EYE.

BY L. RAMAKERS.

A discovery of the greatest importance has very recently been made in the domain of ocular science. Doctor Walther Thorner, assistant at the clinic of eye diseases at the Royal Charity Hospital, has solved a problem that several practitioners had a long time previously studied with indifferent results. He has succeeded in photographing the back of the eye and in obtaining good reproductions of the photographs. His invention is a great improvement upon the Helmholtz eye speculum, which permitted only of examining the back of the eye, while now an image of it can be fixed.

The failure of all attempts made up to the present to photograph the interior, and the back, of the eye has been due to the peculiar structure of this organ. It is difficult, in fact, to illuminate the eye sufficiently to obtain a photograph of it; and even upon employing powerful sources of light, the exposure of the organ would take too long and would occasion unendurable pain to the patient.

Dr. Thorner in the first place constructed an apparatus by means of which he succeeded in photographing the eyes of certain animals and principally those of cats. As the back of the eye is darker in man than in the cat, it became necessary to introduce certain improvements in the apparatus before it was possible to photograph the back of the eye of man. Owing to such improvements, the inventor has finally obtained complete success. The wide-open eye illuminated by the soft light of a kerosene lamp, is placed at the entrance of the apparatus (Fig. 1). A lens reproduces an exact image of the interior of the eye on a plate of ground glass. After an accurate focusing has been secured, the shutter is closed and set and the ground glass is replaced by a sensitized plate. A simple pressure operates the shutter, and, at the same moment, an electric spark ignites a quantity of flash-light powder. The illumination lasts for a sufficient length of time to allow the back of the eye to be reproduced upon the photographic plate. The images thus formed are still slightly imperfect, and it is necessary in developing them to exercise particular care in order that good negatives may be obtained, which shall permit of making positives such as are represented in Figs. 2 and 6. Among these images may be seen both healthy eyes and diseased ones. Here we observe the ramifications of the delicate vessels of the retina, the heavy lines representing the veins and the less conspicuous ones the arteries. It is through the observation of such details that healthy eyes are distinguished from diseased ones. Very short-sighted eyes, for example, are characterized by a peculiar aureola around the center which emits a very light radiation after the manner of a sun. (Fig. 5.) It is therefore now possible gradually to follow the progress of an eye disease through its successive periods, and likewise to photograph each of the parts of the interior of the eye separately.

Owing to Dr. Thorner's patient researches, the delicate art of the oculist is destined to enter a new phase which will doubtless be the starting point of interesting discoveries in the domain of ocular science.

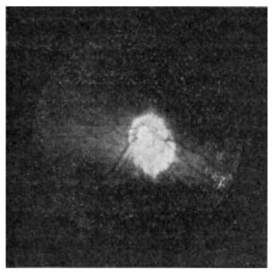


Fig. 2.—Right Eye of a Boy sixteen years of age, Showing a Normal Optic Nerve.

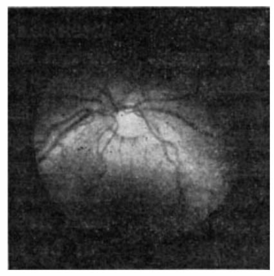


Fig. 3.—Right Eye of a Girl fifteen years of age, Showing a Normal Optic Nerve.

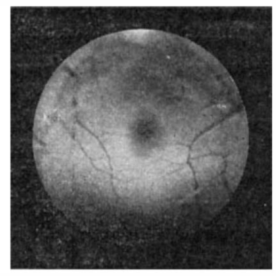


Fig. 4.—Photograph, Showing what is Commonly Called the "Yellow Spot," the Most Sensitive Place in the Eye.

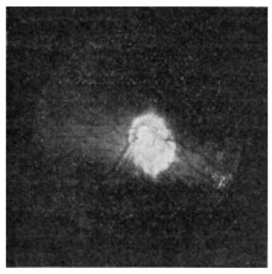


Fig. 5.—The Optic Nerve of an Eye Affected with Myopia to the Highest Degree.

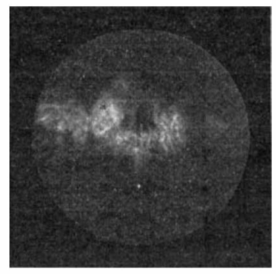


Fig. 6.—Eye Affected with Choroiditis (Inflammation of the *tunica vasculosa*) in the *macula lutea*.

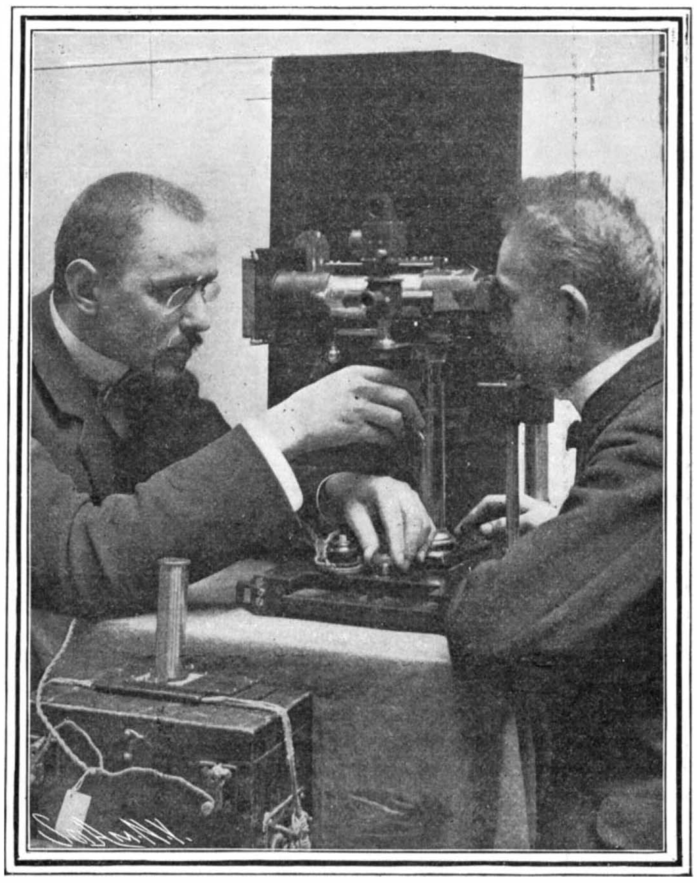


Fig. 1.—APPARATUS FOR PHOTOGRAPHING THE INTERIOR OF THE EYE.

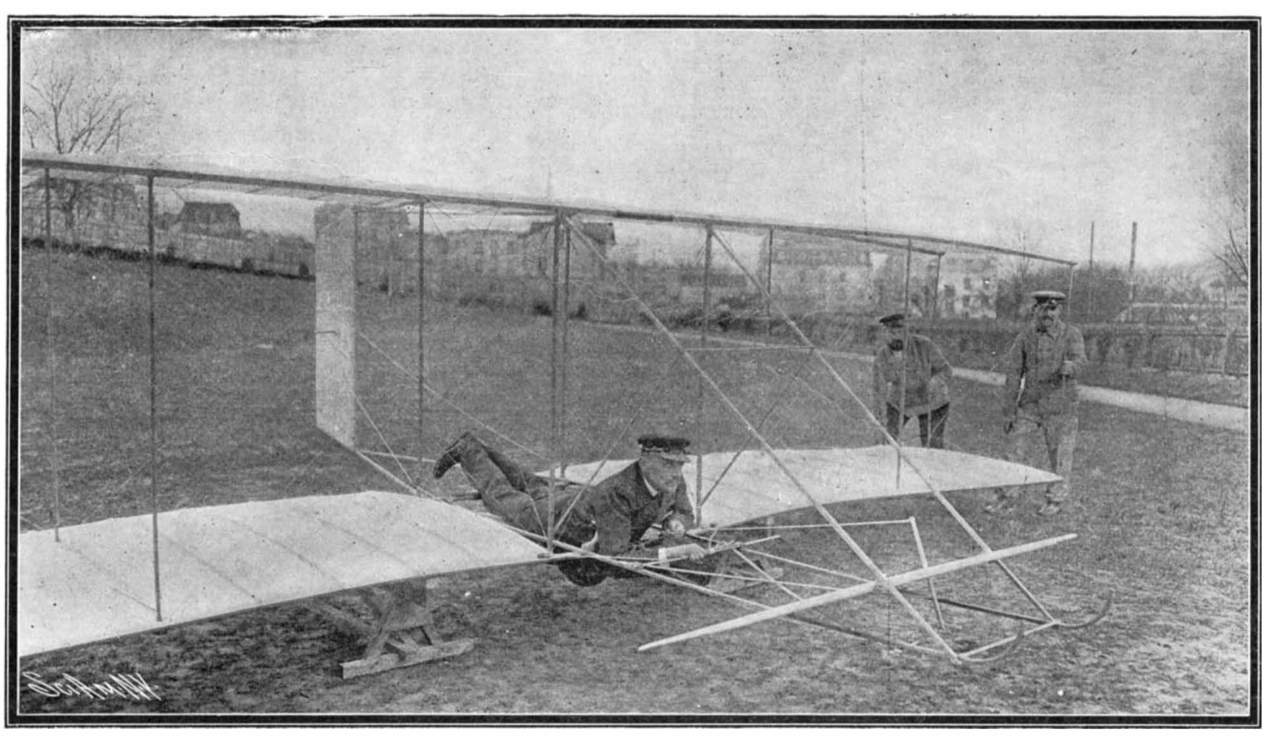
At a largely attended meeting of teachers in London the other day, Mr. Mosely said that "the broad-minded way in which American engineers in South Africa tackled the propositions brought before them was what first excited his interest in the system of education in the United States." He believed that it was the fourth "R" which was at the bottom of education in this country. "Children are taught not only how to read, but how to reason." This was the spirit which permeated the whole nation and largely helped to build up its commercial success. Prof. Armstrong deprecated the tendency here to make our manual training schools into trade schools—"a magnificent metal workshop here and a magnificent wood workshop there." What would be more useful was a training for a variety of occupations with reference to local requirements.—N. Y. Evening Post.

AEROPLANES IN FRANCE AND M. ARCHDEACON'S APPARATUS. — RULES FOR CONCOURSES.

Experiments with aeroplanes are now taking a fresh start in France, mainly owing to the efforts of M. Ernest Archdeacon, an enthusiastic aeronaut and member of the Aero Club. Airships have hitherto occupied the attention almost exclusively, but at present a number of aeroplanes are being constructed, and it is expected to hold a series of concourses during the coming season. The Aero Club has appointed a commission, headed by M. Archdeacon, which will look after this branch of the subject, and it has now drawn up a series of regulations for the different events which are to take place. Competition will be greatly stimulated by the fact that M. Henri Deutsch (who offered the $20,000 prize for airships) has now founded a prize of $5,000 for aeroplanes. The prize is to be awarded for the first aeroplane which will cover one kilometer (0.62 mile) including the forward and return trip. A subscription fund, of which M. Archdeacon is the first contributor, is now being raised in Paris for a similar purpose. This movement shows the interest which is now being awakened in the subject. Among the new aeroplanes which have been built or are now in construction in France may be mentioned that of M. Archdeacon, then Capt. Ferber's apparatus, which was one of the first to be built in France, after the work of Chanute in America. The Drzewieck aeroplane is in construction at the Chalais-Meudon aeronautic establishment near Paris.

M. Archdeacon's aeroplane is shown in the engraving, mounted by the aeronaut. It was built at Chalais and then taken to the Aerostatic Park at St. Cloud. It resembles the Wright (American) aeroplane in its general principles, but contains different modifications in detail which will no doubt make it an improvement over the former. It is built of an ash frame braced by steel piano wires of 0.06 inch diameter. The frame supports two superposed planes which are slightly convex from front to rear. The planes are formed of extra light French silk and measure 24 feet long and 4.5 feet wide. The planes are spaced 4.4 feet apart. The total surface is 25 square yards. The effective surface is slightly less, owing to the lower frame which supports the aeronaut in the position shown. The aeroplane has a horizontal rudder in front and a vertical one in the rear. The whole apparatus weighs about 75 pounds and is very strong in spite of its light construction. M. Dargent, the constructor, has succeeded in building it so that it can be taken apart for transportation. The aeroplane is to be taken to the new Merlimont aerodrome near Berck on the channel coast, where M. Archdeacon is to try it.

The new commission of the Aero Club recently held a meeting to fix the question of aeroplane competition and the conditions under which the trials are to be held. Commandant Renard, Messrs. Henri Deutsch, M. Tatin (who has already built the new airship "City of Paris"), Capt. Ferber, Girardot, the automobile champion, and others are among the members. The immense Galerie des Machines at the Champ-de-Mars is to be placed at the disposal of the aeronauts, who will find ample room for making the preliminary experiments. More extended trials are to be made on different spaces of ground near Paris, and the main concourses of aeroplanes will be held at Berck, where the flat beach affords a good place. Commandant Renard proposed a set of rules for regulating the future competitive tests of aeroplanes in France, and these have been adopted. This is an important point and makes it possible to compare the aeroplanes with each other.



ARCHDEACON'S FLYING MACHINE.

The rules which have been advocated by Commandant

Renard for comparing the flight of different aeroplanes and thus make the competitive tests possible, are the following. The rules apply to aeroplanes without motors, and either with or without an aeronaut. Three series of tests are to be considered: 1. Tests of the most gradual slope. 2. Tests of sustaining quality. 3. Tests of specific lightness. For the tests of the most gradual slope, the landing is to take place within a sector having its center at the starting point and determined by the commission. The axis of the sector is to be directed against the wind, and its total amplitude is not to exceed 40 degrees. The apparatus will be observed at the moment when it passes two test lines perpendicular to its trajectory. At each of the observations the height above the line will be measured and the instant of passage will be chronometered. An anemometer will be installed at least 30 feet above the summit of the hill used as the starting point. If E represents the horizontal distance of the two test lines, E' the distance traversed by the wind between the two observations, H the height of the apparatus also between the two readings, the slope will be given by the formula

$$\alpha = \frac{H}{E + E'}.$$

It is this fraction which is to be used as the base for awarding the prizes or determining the records of the minimum slope made by the aeroplane.

The sustaining power Q of an aeroplane is equal to the ratio $\frac{\lambda}{\lambda'}$ of its load λ per square meter to the load λ' of a parachute falling in a straight line with the same vertical speed V. To obtain the load per square meter, it suffices to measure the weight P of the apparatus at rest and the carrying surface S. We then have

$$\lambda = \frac{P}{S}.$$

On the other hand, we measure the height of fall H during a given time T; whence

$$\frac{H}{T} = V$$

will give the speed of fall. We then calculate the surface λ' which the parachute would have when falling with the same speed by the formula

$$\lambda' = 0.085V^2;$$

V being the measured speed $H \div T$ and 0.085 representing the mean coefficient of air-resistance. The ratio

$$\frac{\lambda}{\lambda'} = Q$$

which is thus obtained will serve as the base for awarding the prizes and establishing the record of sustaining quality of the aeroplane. In this case it is not necessary to measure the speed of the wind.

The specific lightness of the aeroplane is the ratio

$$\frac{P'}{P''} = L$$

of the net weight P' sustained, to the weight P'' of the apparatus, including the planes. The weights P' and P'' are easily found when the apparatus is at rest. The fraction L is to serve as a base for giving the prizes and for records of specific lightness of the aeroplane.

The total value of the apparatus is defined by the number of points given to it, letting C, C', and C'' represent the value from the standpoint of minimum slope, sustaining capacity, and specific lightness respectively. Each of the awards C will vary from 0 to 20, and the total value will be obtained from the formula

$$G = C + C' + \tfrac{1}{2}C''.$$

The awards C will be determined by the following formulæ:

1. For the minimum slope:

$$C = \frac{1}{\alpha}$$

which gives the maximum of 20 for $\alpha = 1\text{-}20$.

2. For sustaining quality:

$$C' = \frac{1}{5}Q,$$

which gives the maximum of 20 for $Q = 100$.

3. For specific lightness:

$$C'' = 4L,$$

which gives the maximum of 20 for $L = 5$.

The United States Bureau of Naval Construction has made an inquiry into the expense of building warships in government yards, and in the report decides in favor of private companies. This is due to the fact that government workmen are paid higher rates.

Raising Drug Plants.

BY GEORGE E. WALSH.

The United States raises a good many of its medicinal plants, but it is so addicted to the drug habit that it pays an annual bill of some $16,000,000 to other countries for importations. If these drugs must be used, it is only natural to ask if the patient cannot save some of the money by encouraging the home industry. A good many of the drug plants are products of the tropics, and cannot be raised here; but expert authorities inform us that some four or five million dollars' worth of the others could readily be produced in the back-yards of our suburban homes.

The early pioneers in this country considered their herb and medicinal gardens of prime importance; but with the development of medicine, and particularly in the establishment of the ubiquitous drug store, this practice fell into disuse. There was no need to raise your own medicinal plants. They could be obtained much easier, and at little expense, at the apothecary's.

There has been a steadily increasing shortage in the common golden seal, or *Hydrastis canadensis*. At one time golden seal was so abundant in the East that it was torn up and burnt by farmers to keep it from overrunning their fields. In the Ohio Valley it was considered a pest. But to-day it is worth about 75 cents per pound wholesale in the market, and it is eagerly hunted for by drug plant collectors. There are scarcely 150,000 pounds collected annually in this country, and the actual demand is several times this amount.

Golden seal will grow easily on rich, loose garden soil. The soil should be made to imitate that of the woods or forest as nearly as possible. The plants are put in rows six inches from each other, with a foot between each row. It takes about three years from planting before harvesting, and after that an annual supply of roots should be had. In two seasons the original plants should increase four times by dividing the rhizomes, which can be cut up in the fall. After the second year the increase should be much faster, for the rhizomes can be cut into small pieces, and each one bearing a bud will form a new plant. The original plants can either be obtained from the woods or from nurseries. In either case they should be planted in late summer, and carefully protected the first winter.

The cultivation of seneca root, or snakeroot (*Polygala senega*), has also been undertaken in this country. Like golden seal it was at one time very abundant in this country, and it was gathered by collectors of drug plants in the South. The annual shortage has sent the price for it soaring. *Cascara sagrada*, *Rhamnus purshiana*, and the coneflower, or *Echinacea angustifolia*, are also running short in this country, and their cultivation could be undertaken with a sure knowledge that prices would be maintained for years to come. Plantations of these drug plants should yield a good income after the second year, and if the propagation increased by cuttings, the supply should be satisfactory.

A curious fact in regard to the drug trade is that we are to-day importing in considerable quantities ordinary medicinal plants which are found growing wild in this country, and are largely neglected. In some cases these wild plants are destroyed by farmers as noxious weeds, and their very presence on the farm is an eyesore to them. In this class of despised drug plants we have the common dandelion, burdock, couch grass, and curly dock. The poor Italians of our towns and cities are apparently the only ones to appreciate the value of these common medicinal plants. In the spring and summer of the year they go forth to dig the roots of the dandelion and dock in gardens, lanes, and by the roadsides. In speaking to one of these Italian collectors, the writer ascertained that he made nearly a hundred dollars a year in this way. Only a small fraction of his time was given to collecting.

Fair prices are quoted in the drug trade for dock and dandelion roots, and the cultivated sorts are so much superior to the wild that there is money in them. All that the farmer or householder needs to do is to start a rich piece of damp ground with the roots of the dandelion or burdock, and then by transplanting cuttings each year a large supply could be raised. The plants take possession of the soil, but the small ones should be thinned out to give the better growths more room. To cultivate dandelions, burdock, and couch grass seems like an absurdity to some, but we have it upon the authority of the Department of Agriculture that many tons of these roots are imported annually into this country for the drug trade.

Experiments have been made to introduce the camphor and cork trees in the Southern States, and some little success has been attained; but it would seem much more to the point if farmers would attempt the cultivation of wild native plants that we now have to import to meet the ordinary drug trade demand. There is common sage, which we raise in such small quantities that we have to depend upon Italy for our needs. The prices for sage are small, and this fact has discouraged many from undertaking to raise it. But the plant is easily cultivated, requiring practically no great attention, and its annual crop of leaves is large. Five or ten acres devoted to sage growing yields excellent returns on the money and labor invested. It will grow in soil that is not very rich, and once the plantation is started, it continues to yield an income for the simple work of harvesting it. To make it profitable, it should be raised on a fairly liberal scale—not less than five or ten acres. In the South in particular it can be raised at little cost. It can be started from seed, and then increased rapidly by cuttings, so that within two or three years a plantation should be in full growth. The leaves are simply stripped from the bushes and dried out of doors on wooden racks, after which they are baled for market.

Belladonna, henbane, and stramonium grow in this country under cultivation, so that good crops can be harvested, and they all occur here as wild plants or weeds. We import quantities of all three from middle and southern Europe, and pay a good price for them. All of these are susceptible to culture in small gardens, their roots growing rapidly, and their leaves furnishing an abundance of medicinal material for drug purposes. Stramonium is an annual, and must be planted from seed each year, but belladonna and henbane are biennials, and can be increased by root division. The leaves are collected and dried in warm, airy places for market.

Prices for these drugs are moderately good, and an acre of land devoted to their culture should yield fair profits. The labor of cultivating is small, the chief item of expense being harvesting and drying of the leaves. In the case of belladonna the roots are also collected and sold for medicinal purposes. The work is all light, interesting, and profitable for man or woman.

While caraway, anise, and coriander seeds are not usually classed among drugs in the eyes of the average person, they are thus classified by dealers. They are imported in large quantities from other countries. The value of imported anise-seed oil alone is nearly one hundred thousand dollars. All three of these plants can be successfully raised in the average well-drained garden. The seeds are gathered just before they are ripened, and when dried they have a steady market at nearly all seasons of the year. Unlike many garden products, they are not subject to violent fluctuations in price, nor are they perishable goods if held for some time, or shipped to a distant market.

We import nearly three million dollars' worth of crude opium for smoking purposes or in the form of alkaloids derived from the opium poppy. In many parts of the South the true opium poppy grows successfully, and the products are of the highest commercial value.

There is needed a well-drained, rich soil for the opium poppy, and the small seeds are drilled or sown into rows. There is more skill required for this plant than most of the others mentioned. When the capsules appear on the plant they are gently scraped or scored with a knife, and through this slight incision the milk of the plant oozes. This quickly coagulates, hardens, and turns black. It is collected then for medicinal purposes, and refined by various processes. The incision on the capsule is not deep enough to injure the maturing of the seeds, which later are shaken out, and the oil is expressed from them. Southern California, Texas, Florida, and other Southern States appear adapted to the culture of the opium poppy for commercial purposes.

We import some 40,000 pounds of thyme oil, which is made from the ordinary thyme of our old New England gardens, while great quantities of the leaves are used for culinary purposes The commercial growing of thyme on a small scale should prove a profitable industry, especially as a side issue in gardening or farming where land is cheap and plentiful.

Lavender oil is of medicinal value, and lavender seeds and leaves of great toilet value. Our total importations of this oil and leaves amounts in value to over one hundred thousand dollars. The lavender of commerce is raised in this country for private uses, and it should find a place in the ordinary garden of drugs that one starts for profit. Its sweet odor should add materially to the pleasure of cultivating the plants.

Chamomile flowers, senna leaves, and the leaves and flowers of saffron and safflower are imported for the drug trade to a total valuation of about $170,000. They are all plants that thrive in this country, and in the early New England days, when drug-stores were scarce, they were found in nearly every herb or medicinal-plant garden. They are found growing wild in some parts of this country, especially in the neighborhood of old gardens, where they were probably at one time cultivated.

The roots of sarsaparilla grow wild in the Carolinas, and they have been cultivated to some extent in other parts of the country, while orris, gentian, and ginger roots have been experimented with in the warm Southern States.

THE BIOSCOPE—AN INSTRUMENT FOR THE STUDY OF INSECT LIFE.

BY EMILE GUARINI.

The highly-improved and powerful microscope, to which modern science is indebted for most important discoveries, and the value of which is inestimable in certain domains, is becoming inadequate for the prosecution of some lines of study. It is capable of revealing the inmost structure of minute beings that escape our sight, and of counting the number of cells of which they are composed, but it is almost impossible to observe with it the phases of the normal life of such organisms. How, in fact, can we say that we observe the normal life of an organism when, in order to examine it, we are obliged to bring within a fraction of an inch of such an organism an apparatus that cannot fail to frighten it? In order to observe the normal life of microscopic organisms another instrument is therefore necessary, a long-focus microscope capable of being used in cases in which the ordinary instrument becomes inadequate. It is such an instrument that has recently been devised by M. De Gasparis, of the University of Naples, and constructed by the Contaldi establishment of the same city.

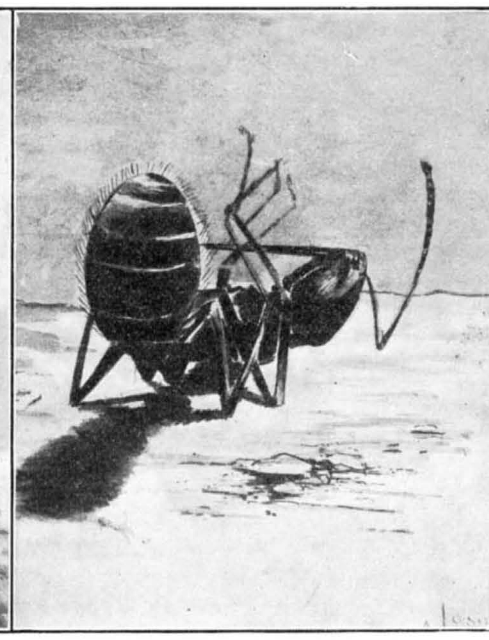
The apparatus, which is called a "bioscope" by its inventor, was recently exhibited to the Regio Instituto d'Incoraggiamento di Napoli. It is really a very long-focus microscope designed, as its name implies, for the study of the phenomena of animal life in all cases in which it is impossible for the observer to get close enough to the object that he is examining without running the risk of misinterpreting what he sees The apparatus therefore permits of obtaining the completest understanding possible of the normal life of insects, of the various manifestations of their intelligence, of their customs and habits, and of their relations with each other and the external world.

The apparatus, which is extremely simple, is shown in the first of the accompanying engravings. It is provided with a *camera lucida* to permit of the drawing of the objects observed. It consists of a tube with a rack provided internally with a system of achromatic objectives perfectly free from spherical aberration, and with a wide-field eye-piece. The apparatus is also provided with a system of mensuration and various arrangements for supporting diaphragms. At a distance of 19.5 inches, the microscope has a magnifying power of more than 12 diameters, say of 144 times the surface

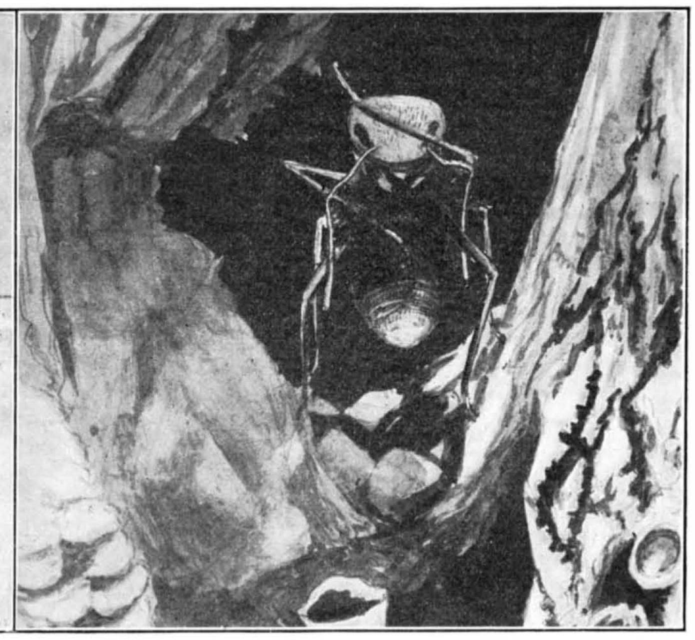
In the field of the bioscope, the astonished eye of the observer perceives a new world—a series of scientific surprises. Hatred, anger, joy, and love are depicted in the acts of the infinitely small; we distinguish their weapons and their wounds and observe their palpitating viscera through their sides, and see their minute bodies, in the last convulsions of the agony of death, trembling with a final spasm.

Ants furnish a particularly interesting field for observation. We see, in our various illustrations, an ant making its toilet at the entrance of a formicary covered externally with lichens and mosses; a battle be-

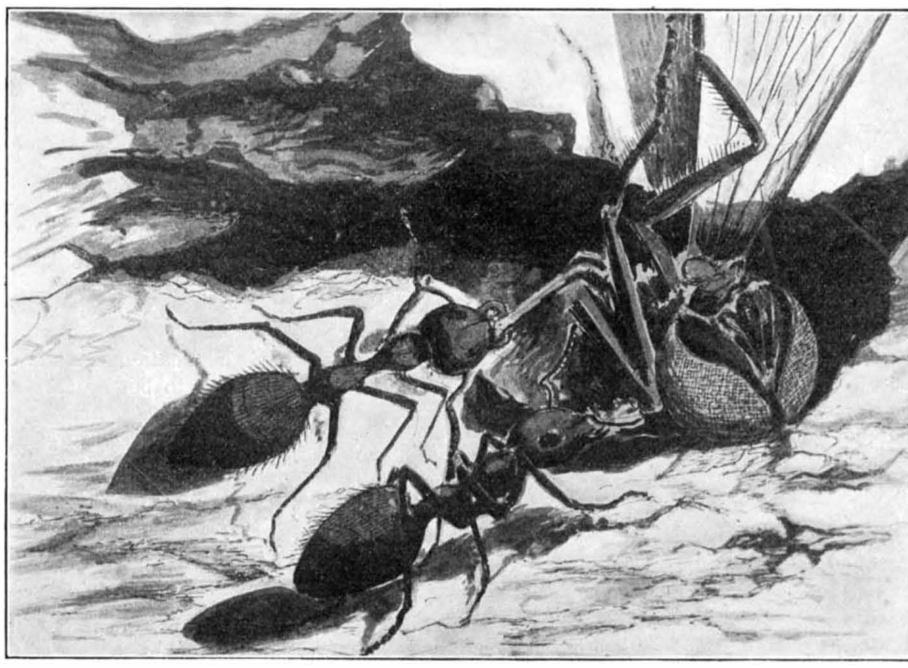
How the Bioscope is Employed.



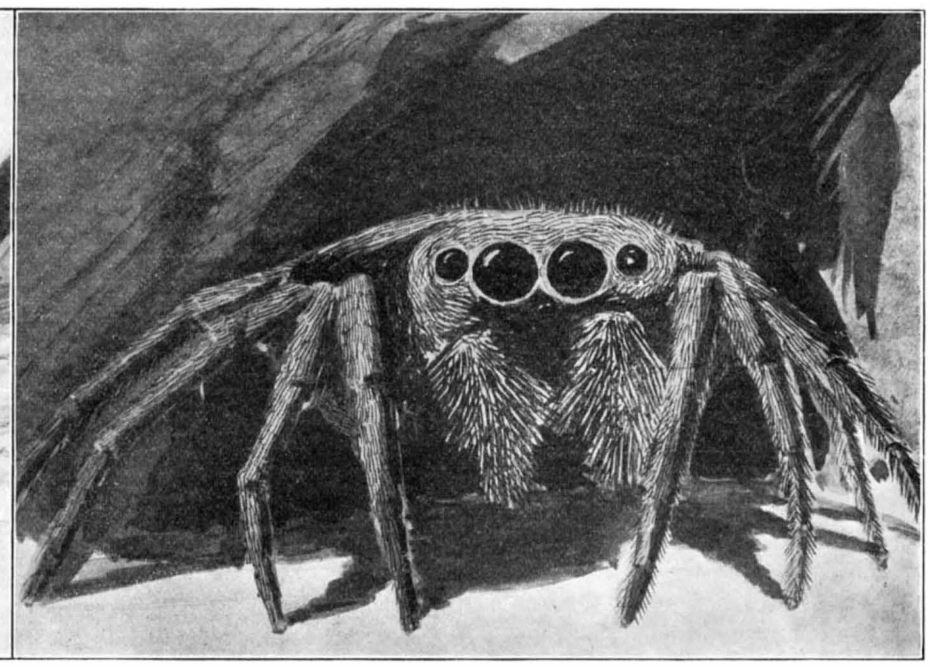
A Crippled Ant.



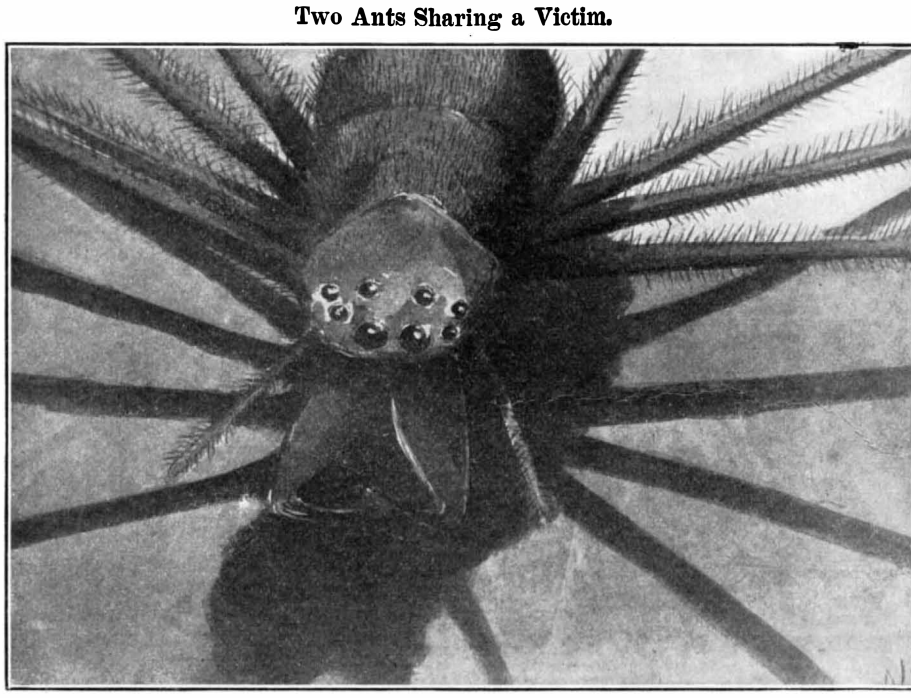
An Ant Cleaning Itself.



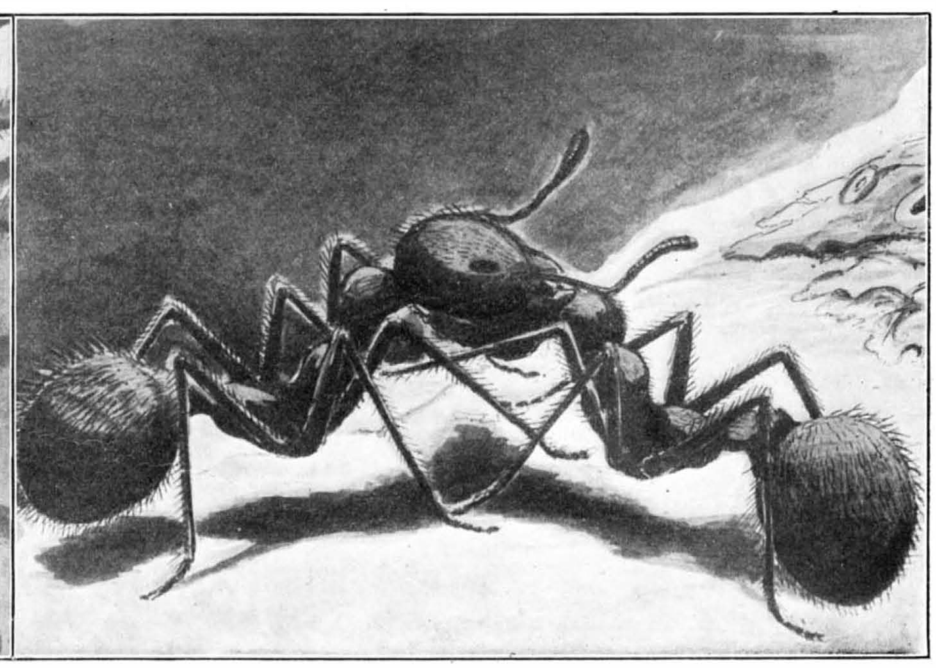
Two Ants Sharing a Victim.



Small Spider Preparing to Pounce on Its Prey.



What a Spider Looks Like Through the Bioscope.



The Fierce Battle of Two Ants.

DE GASPARIS'S BIOSCOPE—AN INSTRUMENT FOR STUDYING INSECTS.

tween two ants; an ant lacerating the abdomen of a fly; two ants sharing a large victim with each other; a sun-struck ant, etc. Spiders are no less curious objects for observation. We may see especially, with interest, the common leaping spider (*Satticus scenicus*) at the moment at which it is leaping from a fissure upon its prey, and remark its preparations previous to leaping, etc.

The struggle for existence among these small organisms takes on a character of almost human unsociableness. The smallest animals present themselves in the light of genuine monsters. Their rapid motions, evoked by no external cause, reveal their muscular power. The environment in which they live appears through the apparatus like a landscape with strange and fantastic forms, made attractive by multi-colored plants of which the transparent structure carries our thoughts into other worlds or toward the remote epochs of the prehistoric ages of our planet. The bioscope is no less valuable for scrutinizing the life of aquatic animals through the sides of an aquarium, or even in their natural element. It permits of studying bodies submitted to very high temperatures, electric discharges, etc. In the domain of medicine, it renders possible the observation, under a strong magnification, of dimly lighted cavities (the larynx, ears, etc.), and of formulating a diagnosis in many cases that have up to the present been doubtful.

The bioscope, therefore, cannot fail to give the sciences of observation a new impulse. It has the advantage over the microscope of not necessitating a knowledge of a special technique, delicate and difficult to acquire. In this respect it puts scientific observation within reach of the amateur, who, as there are many examples to prove, is not to be despised.

New Researches on Photographic Photometry.

BY THE BELGIAN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

MM. Carlo Cesari and Cesare Manicardi have recently made a very interesting double series of experiments upon photographic photometry, the results of which they have communicated to the Royal Academy of Sciences, Letters and Arts of Modena, and which are of too great importance to remain buried in the publications of this learned society, since the two new experimenters, contrary to the procedure of their predecessors, made it a point to conduct their researches in the interest of industrial practice. It is the result of such researches and the method employed for obtaining them that we shall endeavor to describe in the lines that follow.

A comparison between a standard source of light and any other luminous source may be effected by making a quantitative chemical analysis of a deposit of silver reduced upon a sensitized plate through the effect of light. In order, however, that the results shall present guarantees of accuracy, the operation must be performed very rapidly.

In order to obtain the most favorable conditions for their experiments, MM. Cesari and Manicardi decided to select a constant time of exposure; and for the purpose of obviating the inconvenience of the diversity of the images, the photographic objective was discarded and replaced by a system of lenses causing a parallelism of the rays that strike the plate at right angles. They also operated without any lens at all and caused the light to pass through the round aperture designed for the objective. In both cases, the results were exactly proportional. The first method, however, is preferable because it gives a sharper image upon the plate. The determination of the quantity of metallic silver liberated under the action of a source of light may be obtained directly or indirectly. The indirect method, instead of making known the quantity of silver liberated, shows the quantity that has not been reduced. It is based upon the dissolving action of hyposulphite of soda. Although it appears to be practical and permits of preserving the negative, it presents two drawbacks that compelled the experimenters to discard it. In the first place, there is no certainty that two plates contain exactly the same quantity of silver, and, in the second, the recovery of such silver requires a long and complicated operation. All that remains to be done, then, is to ascertain the quantity of reduced silver directly. With this object in view, the negative is treated with hot nitric acid, which converts the silver into nitrate and destroys the organic matter—the gelatine of the plate. The whole is then evaporated to dryness on a water-bath, and the residuum is taken up by dilute nitric acid. The solution obtained is very well adapted for volumetric quantitative analysis. Through treatment with chromate of potash and hydrochloric acid, diluted one-tenth, the results obtained are exact to within about a hundredth of a milligramme.

About fifty minutes suffice for obtaining the photometric results sought. The standard luminous source and the source to be studied are photographed under absolutely identical conditions, and then the determination of the reduced silver is proceeded with.

The following are some of the results obtained with this method. In order to obtain them use was made of Capelli plates and a system of biconvex lenses of 2 centimeters diameter and having a focal distance of 23 centimeters. A Carcel lamp of 9 English candle power was selected as the photometric unit. With this lamp, the experiments gave, for the silver reduced, an approximate value of 0.002 gramme, say about 0.00022 gramme per candle. With a gas flame, Bengel tube type, at a pressure of 15 millimeters, consuming 105 liters, and equivalent to the ordinary Carcel lamp photometer, there was obtained, in the first experiment, 0.0019 gramme, in the second, 0.00195 gramme, and, in the third, 0.0019 gramme of reduced silver.

A free bats-wing gas flame, with No. 7 burner, having a pressure of 28 millimeters and a consumption of 180 liters, and equivalent to the ordinary photometer at 1.2 carcel, gave 0.00242 gramme in the first experiment and 0.0024 gramme in the second.

A free gas flame, with No. 6 burner, with a pressure of 28 millimeters and a consumption of 125 liters, and a photometric value of 1 carcel, gave 0.0019 gramme of reduced silver in three successive experiments.

A circular tube gas burner, with a pressure of 28 millimeters and a consumption of from 200 to 250 liters, equivalent to a 1.8 carcel photometer, gave 0.0036 gramme in the first experiment and 0.0035 in two subsequent ones. Finally a No. 2 Auer burner with a mantle 1.5 centimeters in height, a pressure of 30 millimeters, a consumption of 110 liters, and a photometric value not exactly determined, gave 0.005 gramme of reduced silver in two experiments and 0.005 in another.

In the second part of their study, the experimenters made a comparison of various flames. For this purpose they employed panchromatic and orthochromatic plates with and without colored screens. The panchromatic plates were of the Lumière and the orthochromatic ones of the Capelli type. The *modus operandi* was slightly changed in order to prevent the rapid alteration of the nitrate. The negative, well washed with water, was placed in a porcelain tray containing nitric acid concentrated to a maximum, and provided with an opaque cover.

The nitric acid quickly destroyed the greater part of the organic matter, even when cold, and left the silver intact in the form of nitrate. The liquid thus obtained is not very limpid, but is very well adapted for volumetric quantitative analysis when it is diluted with distilled water. On the other hand, the analyses were made in employing a normal solution of chloride of sodium as a developing liquid.

Three experiments were made with the panchromatic plates. With the Carcel lamp the deposit of silver was respectively, in the three experiments, 0.004158, 0.004163, and 0.004161 gramme.

With a free bats-wing flame (consumption 125 liters, and equivalent to 1.5 carcel), the figures were 0.0061, 0.0063, and 0.00648 gramme of reduced silver. With a circular tube gas burner (consumption 200 liters, and equivalent to 1.8 carcel), 0.00701, 0.0072, and 0.00739 gramme of reduced silver were obtained. With an Auer mantle burner No. 2 (consumption 110 liters), 0.0225, 0.02245, and 0.0226 gramme of silver were deposited.

Two series of three experiments were performed with the orthochromatic plates, one with a grass-green screen, and the other with a bright orange-yellow one. With the first, the Carcel lamp gave respectively 0.002169, 0.0022 and 0.002142 gramme of reduced silver. With the free bats-wing flame (1.5 carcel), the figures were 0.0029, 0.00289, and 0.00291. With the circular gas burner (1.8 carcel), the figures were 0.0034, 0.00341, and 0.003402. Finally, with the Auer No. 2, 0.01001, 0.01, and 0.010002 gramme of reduced silver were obtained.

With the yellow screen, the Carcel lamp permitted of obtaining, respectively, in the three experiments, a silver deposit of 0.001854, 0.001852, and 0.001855 gramme. The free bats-wing flame gave 0.002012, 0.002169, 0.0022, and 0.002142 gramme of reduced silver. circular gas burner permitted of obtaining a silver deposit of 0.0031, 0.00314, and 0.003069 gramme. Finally, the Auer burner gave 0.0092, 0.009601, and 0.00902 gramme.

These experiments were supplemented by some others with ordinary plates. In these, as in the preceding, three were made with each luminous source. The results were not without interest. The Carcel lamp gave respective deposits of 0.002 gramme in the three experiments; the free bats-wing flame gave 0.0021, 0.00209, and 0.0021 gramme; the circular gas burner, 0.0032, 0.00324, and 0.00317; the Auer burner No. 2, 0.006, 0.00602, and 0.00589; the free flame of the Bengel type (1 carcel), 0.0019, 0.00195, and 0.0019; and, finally, another for bats-wing flame (consumption, 180 liters, and photometric value 1.2 carcel), 0.0028, 0.00282, and 0.0028 gramme.

In all these experiments the pressure of the gas was 28 millimeters. Among all the qualities of plates employed, those that behaved the best were the panchromatic ones. In the absence of such plates, it is possible to perform the experiments with orthochromatic ones with a bright orange-yellow screen, or, if this cannot be had, with a grass-green one; but, in the opinion of the experimenters, ordinary plates must be absolutely discarded as being capable of giving rise to greater deviations.

The results obtained may be very well represented in the form of diagrams of genuine industrial utility, although the curves are not absolutely accurate, on account of the small number of datum points. The accuracy is sufficient, however, for the requirements of ordinary and especially industrial practice.

The Electric Welding of Chain.

BY LESLIE B. POWELL.

Electricity, long acknowledged to be the most important factor in modern manufacture, is being almost daily adapted to new uses, and in most cases revolutionizes the various processes of previous manufacture. Especially is this the case in the recent adaptation of electric welding to the making of chain, doing away entirely with methods thought to be the most modern and labor saving; introducing a process that cheapens the cost of production, and raises the quality of the product.

To a native of France, Eugene François Giraud, belongs the honor of first adapting for commercial use in the manufacture of chain, the principles underlying the science of welding by the electric current. Used in connection with M. Giraud's electric welding machine, is his machine for forming links, an ingenious and complicated device, into which the wire rod is fed and automatically cut and formed into links. As each link is being formed, it is hooked through the link previously formed, so that the links emerge from the chain-making machine cut, formed, and linked together ready to weld.

An important feature of this machine is that the links made thereby are absolutely uniform in dimension and free from twist, and as the process of welding does not in any way alter the shape of the link, the result is a chain with every link exactly alike, increasing its commercial value.

The links thus formed are fed from the chain-making machine directly into the electric welder, where every other link is welded on the first pass through the welder, and the alternate links on the second and last pass.

This is necessitated by the fact that the links present themselves alternately in horizontal and vertical positions, and the welding machine can weld the horizontal links only.

The links are so formed in the chain-making machine that the two ends of the link to be welded are on the side of the link, with a space of probably not over 1-16 of an inch between the ends, which are cut at right angles with the length of the rod in such a manner that they can be "butted" together to be welded.

As each link reaches the proper position, it is firmly seized by jaws, and the ends of the link to be welded brought tightly together. At the same time, two dies are operated so as to close on the link at the point where it is to be welded; and the moment these two dies touch the link, the connection is made, bringing the parts of the link between the dies immediately to the welding heat.

By means of the pressure and the heat, the link is thus welded in such a manner that the welded portion of the link is as perfect as the rest of the link, with the exception of a slight ridge formed by the pressure.

As soon as welded, the link is carried automatically forward to a point where, by blows of a die, the ridge is reduced to the size of the balance of the link.

As this latter operation is taking place, the succeeding link is being welded, and so on indefinitely.

There are numerous features about this process of chain manufacture which tend to make it of extreme commercial value. The absolute certainty of the weld, and the fact that there is no waste heat, is an important item.

Skilled and high-priced labor will be done away with to a great extent, the cost of manufacture greatly reduced, and the daily production increased, one welding machine turning out about 18,000 links of 5-16-inch chain per day, equal to about 2,000 pounds in weight.

The current required for operating one machine is not more than 24 watts per square millimeter of double section of material used.

A great amount of time and money has been spent in experimenting, in order to make chain without welding, but to no practical avail; but here we have a process that guarantees a perfect weld, perfect links, and enormous production at a cost which is less than the most inferior chain to-day can be made under.

Steps are now being taken by prominent chain manufacturers in this country toward installing this process of chain manufacture.

It is stated that M. Pelletan has signed an order to begin building ten defensive submarines. Six of the small boats, which will not weigh more than 44 tons, will be constructed at Cherbourg and four at Rochefort.

IRRIGATION IN SOUTHERN CALIFORNIA.

BY DAY ALLEN WILLEY.

As an example of the beneficent results of irrigation of desert lands, a project which has been undertaken in Southern California is probably one of the most notable in America, for its promoters selected a region most of which was entirely devoid of vegetation in any form, the soil, if it can be called such, not even containing enough elements of fertility to nourish the sparse vegetation found in the so-called desert of the Southwest. Prior to the reclamation of this land, one could travel for miles without seeing any vegetation.

Most of the area referred to forms a part of the Colorado Valley, and is situated in San Diego County. The head of the canal was located on the river at a point seven miles west of Yuma, Arizona, and but a short distance from the boundary between California and Mexico. Here the elevation is 120 feet above sea level, a sufficient altitude to give an average fall of from four to six feet to the mile. It was found impossible to construct the waterway in a straight line, owing to the topography of the country, and in its course it makes a wide detour, passing through a portion of the Mexican republic. It is unique from the fact that it is probably the only international irrigation canal in the world, the water being used to cultivate a considerable area in the southern republic.

Work was not begun until August, 1900. Nearly all of the canal was dug by the use of horse excavators and land dredges, some of the latter having a capacity for removing from 1,000 to 1,500 cubic yards in ten hours. As the material taken from the bed was utilized for embankments, such good progress was made that farmers in the irrigated district gathered their first harvests of grain as early as 1903. An idea of the magnitude of the work can be gained when it is stated that the main canal is at present nearly 100 miles in length, with the unusual depth of 10 feet, while it varies in width from 100 to 200 feet at the top. These dimensions show that it is one of the largest water courses of its kind in the world, if not the largest artificial channel for irrigation purposes. Over 500 miles of lateral canals have been connected with the main canal. These vary in size from a ditch a few feet in width, carrying a foot of water, to excavations 30 and 40 feet in width, with a depth of five feet.

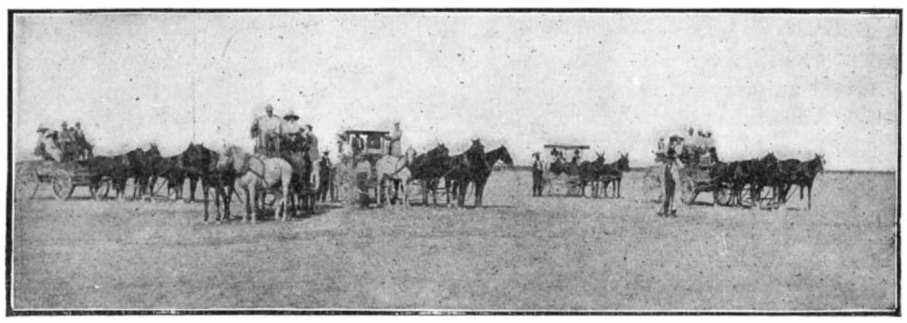
As in the case of other western irrigation schemes, as soon as the canal was sufficiently completed to allow a portion of the territory to be watered, connection was made by laterals, and the land placed under cultivation. As fast as the supply was increased, the area served was increased in proportion, until at present about 150,000 acres depend entirely for moisture upon the system. The land is being reclaimed so rapidly that 250,000 acres will probably be under cultivation within the next two or three years. Water began flowing through the supply canal in the summer of 1902, so that the conversion of the desert into productive territory dates back less than two years. Yet the crops of various kinds which are being secured equal in quality and quantity those obtained from other irrigated districts which have been tilled for ten years and over, which seems to prove that this formation, which in a state of nature could not support even the coarsest vegetation, is of a high standard of fertility when properly irrigated.

In cultivating the Imperial Valley, as it is called, the farms have been divided into small tracts, the largest comprising not over 160 acres. It is probably due in part to the intensive system of agriculture that the results already attained have been so successful. Among the field crops which have been raised with profit are such cereals as corn, wheat, and barley; although barley and wheat do not usually thrive as well in specially irrigated soil as when grown on land which is naturally watered. Sorghum has also been raised successfully, as well as sugar beets. Alfalfa—the forage crop which grows so abundantly in other irrigated districts—has yielded exceptional crops in this valley, and from three to five crops in a year can be cut from a single field. Experiments have also been made in the culture of rice and cotton with fair success, while vegetables and the tree and bush fruits which flourish in other portions of California, bid fair to yield as largely here. The extent and value of the crops thus far secured are shown by the receipts of some of the farms, which have averaged from $60 to $75 per acre.

With the influx of settlers, a condition has arisen similar to that on the prairie lands of Louisiana and Texas, where the cultivation of rice on such an extensive scale has been carried on within the last few years. A number of towns have been located in the heart of what was formerly the desert, some of them having a population of several thousands. These towns form the principal markets for the sale of the products of the district. The town of Imperial, which is the principal shipping point by rail, during the first harvest year sent out on an average five carloads of wheat and barley daily during the season.

An interesting feature in connection with the reclamation of this section of the southwestern desert, is that the canal system carries a large quantity of fertilizing material in solution. The Colorado River, passing over many miles of channel which it has cut through soft material, in times of high water is filled with sediment, as is the Nile at the flood period. When its waters are released into the canal, a large amount of sediment is carried through the artificial waterway, and thus enriches the water which is used in the fields. One objection to this deposit is that it tends to fill up the bed of the canal, but this is kept at a proper depth by dredging. The deposited sediment serves to counteract the natural impoverishment of the land by cultivation.

In the southwestern portion of the United States, the government has planned some of its most elaborate irrigation schemes. Over 120,000,000 acres of arid and semi-arid territory are believed to be available for reclamation with suitable water systems, or more than fifteen times the present area of irrigated territory. Much of this area is suitable for pasturing, and contains sufficient fertility to produce forests of commercial timber. Mention has already been made of what has been accomplished in the Pecos Valley. It is a fact that the products of this valley form the principal traffic of a railroad, built specially to carry them to market, which is 375 miles in length, and represents an investment of $5,000,000.



The Desert Before Irrigation. Not a Blade of Grass in Sight.

Bags of Grain Harvested on the Irrigated Field, Awaiting Shipment.

IRRIGATION IN SOUTHERN CALIFORNIA.

On the morning of September 12 last Encke's comet was rediscovered at the Koennigstuhl Observatory at 17 minutes past 1. The first observation gave its right ascension at 1 hour 46 minutes 16 seconds, and its inclination 27 degrees 24 minutes north. At the time it was seen it was about 2 degrees south of Beta Trianguli, and was moving at the velocity of about one minute of time westward in right ascension and of eight minutes of arc northward in declination. Its course therefore lay due north of the third-magnitude star Delta Andromedæ. It was very faint when first observed, and was distant 107,000,000 miles from the earth, and nearly twice that distance from the sun. It is, however, approaching both very rapidly, the speed being about one million miles toward the sun, and about one and one-half million miles toward the earth respectively per day.

A great convenience around a garage is a pit which permits of the workman taking a position under the machine and working there with some degree of comfort. Such a luxury cannot be indulged in except by those who can afford to go into the pastime extensively enough to warrant a regularly equipped establishment for the housing of several machines. But to answer the same purpose, an inventor has designed a specially-arranged pair of pulley blocks with frames for seizing the automobile by the hubs, and with these the vehicle may be raised and held at any desired height above the floor. The device is made in three sizes to meet the demands of owners having vehicles of varying weights.

The First Iron Works in America.

BY A. N. SOMERS.

It is not very widely known that the first iron manufactured in America was from bog ore taken from the meadows along Falling Creek, a tributary of the James River a few miles below Richmond.

In 1619 the London Company, the proprietors of the colony of Virginia, sent over a Mr. King and one hundred and fifty skilled iron workers to erect furnaces on Falling Creek. These men came chiefly from Warwickshire and Staffordshire, and when once in Virginia named the village that grew up about their iron works Warwick. The company spent about $200,000 in the erection of a furnace and opening the mines, from which for three years they produced a good quality of iron. Mr. King soon dropped out of the enterprise, and a Capt. Bluett superintended the erection of the works; but his career was a short one, after which John Berkeley, son of Sir John Berkeley, a nobleman of much distinction, succeeded to the superintendency of the establishment, and conducted it ably until one day—March 22, 1622—the Indians under Opitchapan, a brother of Powhatan, who had succeeded the latter on his death in 1618, surprised the village and murdered Berkeley and one hundred and fifty men and women. The only survivors of the village were a boy and a girl, who hid in the bushes. This terminated the iron industry, and Warwick was but a name associated with the massacre for a long time. In 1700 mills were built upon the ruins of the iron furnace. In those mills was ground the first flour exported from America, much of it going to South America. From that time on Warwick grew rapidly until it became an important manufacturing and shipping village, as it was at the head of navigation. Shortly before the outbreak of the Revolutionary war, Col. Archibald Cary acquired possession of the vast estate known as Ampthill, that lay on the James River and inland along Falling Creek for a distance. The estate was named after one in England. Col. Cary was an active revolutionist, being chairman of the committee that drafted the first Bill of Rights and State Constitution in America, that of Virginia. When the war broke out, he took an active part in the military operations of his country in the South. Tarleton, the British general, sailed up the James River and burnt Warwick and Col. Cary's mills on Falling Creek. It is said that Benedict Arnold the traitor accompanied Tarleton on this voyage. It was an act in keeping with the baseness of his character to have taken part in such retaliation against the patriotic Cary.

The old Ampthill house occupied by Col. Cary at the time is still standing, and portions of the ruins of Warwick are to be seen. On my recent visit to the locality, a rainstorm drove me into the old Ampthill manor house, where I was kindly received by the present owners, who are descendants of the Cary family. The day was a cloudy one, and I could do but little with the camera, getting only two fairly good views of the site of the old iron works and the Cary mills; but a heavy rain prevented me from taking the house at Ampthill.

The Current Supplement.

The current SUPPLEMENT, No. 1511, opens with an article by Mr. Frank C. Perkins on the manufacture of carbons in England. Excellent illustrations accompany the contribution. Mr. Clifford Richardson's valuable paper on the Constitution of Portland Cement from a Physico-Chemical Standpoint is concluded. A simple German instrument for testing the magnetic properties of iron is described and illustrated. Prof. N. Monroe Hopkins' second paper on Experimental Electro-Chemistry is published. This paper discusses in a simple way the theory of electrolytic disassociation and osmotic pressure and its measurement. By far the most interesting feature of the SUPPLEMENT is a controversy between Prof. Wood and Prof. Blondlot. Prof. Wood sharply criticises the methods adopted by Blondlot in investigating the N-rays, and, indeed, casts doubt on their existence. Prof. Blondlot replics in a paper written at the Editor of the SCIENTIFIC AMERICAN's request. Commander R. E. Peary writes interestingly of his last North Polar trip. Excellent pictures accompany the text. Another installment of the monograph on "Current Wheels, Their Use in Lifting Water for Irrigation," is printed. G. C. Henning tells much that is interesting about diamond tools. Miss Agnes Clerke contributes a paper of absorbing interest, which bears the title "The Procession of the Suns.

BATTLESHIPS "IDAHO" AND "MISSISSIPPI."

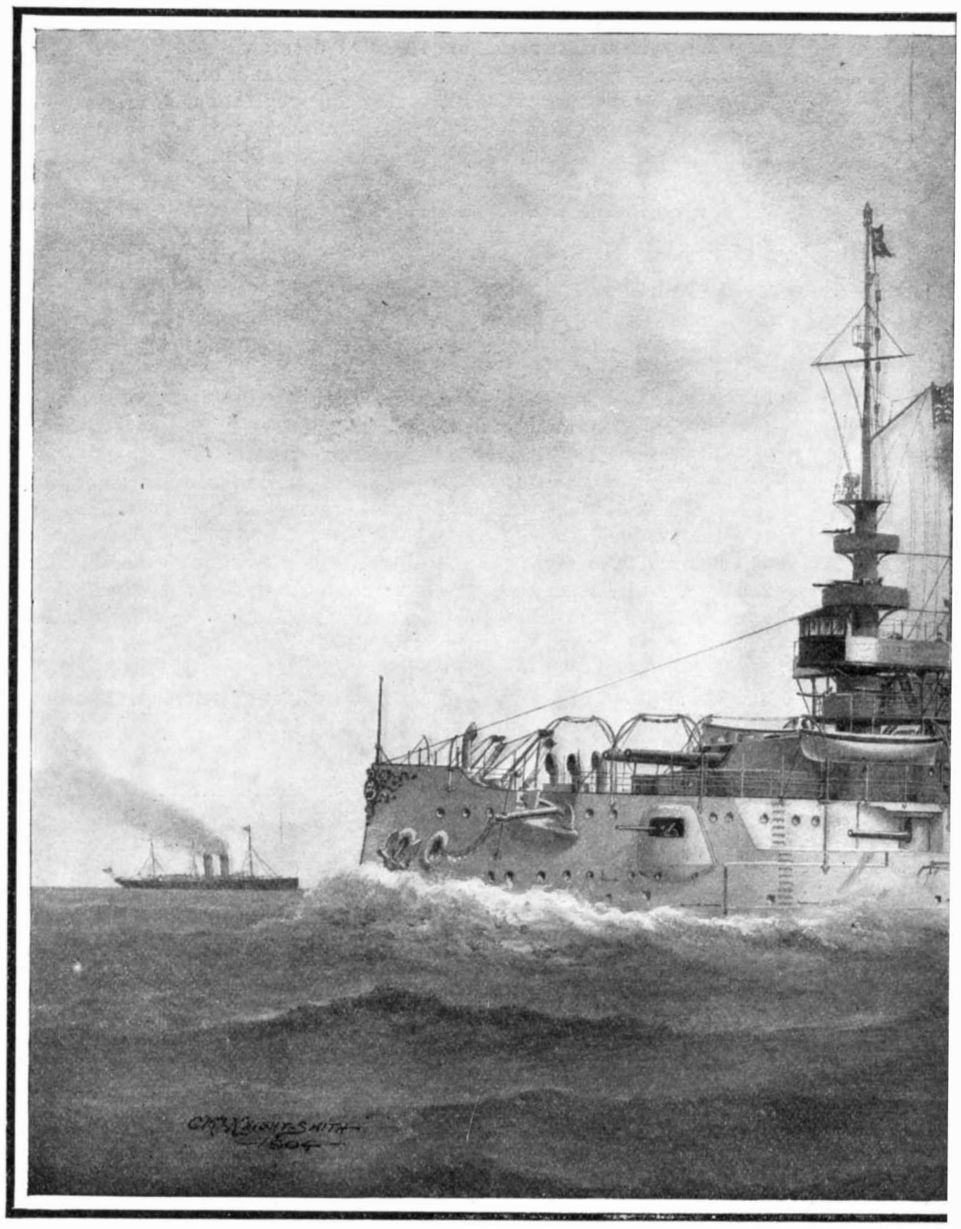
The "Idaho" and "Mississippi" are sister battleships that were authorized by act of Congress March 3, 1903, which specified that the ships were to have the highest combination of speed, defensive armor, battery power, and coal endurance compatible with a displacement of 13,000 tons. The design of these ships was promptly taken up by the Bureau of Construction, and on May 27 the Chief Constructor presented to the Board on Construction five different scale designs for these vessels. On June 10, 1903, the Department adopted the report of the Board, which gave a preference to the design which is shown in the accompanying illustration, and the contract for the two vessels was ultimately let to the Cramp & Sons Company, of Philadelphia, where the vessels are now under construction.

Although we are not familiar with the features of the alternative designs which were submitted to the Board on Construction, it is evident that in the selection of the accepted design the Board was influenced by the desire to make the two ships conform, as far as possible, to the 16,000-ton battleships of the "Connecticut" class, to which they have been compared in language, more expressive than nautical, as "smaller editions." A difference of 3,000 tons in the displacement of two battleships is a large one, of course, and involves considerable sacrifice. If the reader will compare this illustration with views and detailed descriptions that we have given of the 16,000-ton "Connecticut," he will recognize at once most of the changes in battery and general appearance that have been made. In the first place, the length on the waterline has been reduced from 450 to 375 feet; the beam is about the same, 76 feet 10 inches for the "Connecticut" and 77 feet for the "Idaho;" and the respective drafts are 24 feet 6 inches for the "Connecticut" and 24 feet 8 inches for the "Idaho." From this comparison it looks as though the under-water body of the "Idaho" must be somewhat finer than that of the larger ship. A large saving has been made in the engine and boiler-room weights, the designed indicated horse-power being reduced from 16,500 in the "Connecticut" to 10,000 in the "Idaho." With this, there is a corresponding reduction in the space given up to the coal bunkers, the "Connecticut" carrying a maximum of 2,200 tons as against 1,750 tons on the "Idaho"; but, on the other hand, there is a marked gain in the steaming radius at 10 knots per hour, the smaller vessel being able to steam 5,775 knots as against 5,275 for the "Connecticut." The estimated speed on trial, however, of the "Idaho" is but 17 knots, or one knot less than that of the big ship.

A further reduction of weights, a very large one in itself, is gained in the lowering of the quarter deck. In the "Connecticut," the upper deck is continuous from stem to stern; in the "Idaho," it extends from the bow to the after end of the central broadside battery, at which point the freeboard is reduced by about 8 feet, or from say 21 to 13 feet. While there is a considerable loss of accommodation, this cutting down of the topsides is accomplished with a very considerable lowering of weights, and a consequent increase in stability. There is, however, a loss of "command" for the after pair of 12-inch guns. Still another reduction has been made in the absence of the mainmast, the new ships carrying only a foremast, as is the case with the "Oregon" class. A reduction has been made in the armament, which includes the removal of four 7-inch guns, eight 3-inch guns, six 3-pounders, and four 1-pounders. Not only is the weight of these twenty-two guns removed, but also the weight of their mounts, ammunition hoists, and large stores of ammunition.

The battery consists of four 12-inch guns, eight 8-inch guns, eight 7-inch, twelve 3-inch, twelve 3-pounders, eight 1-pounders, two 3-inch field guns, two machine guns, and six Colt automatic guns. The 12-inch guns are carried above two main barbettes, protected with armor varying from 10 inches to 6 inches in thickness, the turret armor varying from 12 inches to 8 inches in thickness, the thinner armor of the barbettes being used in the lower portions, where the barbettes are protected by the armor plating of the ship. The 8-inch guns are carried in four barbette turrets at the four quarters of the ship, the turret armor being 6½ and 6 inches in thickness, and the barbette armor 6 inches and 4 inches in thickness, while that of the sub-barbettes, or that portion which lies behind the 7-inch protection of the ship's side armor, is 3¾ inches in thickness. Eight 7-inch guns are carried in a central broadside battery, which is protected by 7 inches of armor, and they are mounted in recessed ports with semicircular shields that fit closely the port openings. One and one-half inch transverse armor walls, or screens, project from the ship's side between each pair of guns, for the purpose of localizing the effects of bursting shell. The dozen 3-inch guns are mounted as follows: two forward in the bow in sponsons, four upon the upper deck, in broadside between the 8-inch gun turrets. On the superstructure deck are four more guns, two forward and two aft, while the remaining two are carried at each end of the main bridge. The three-pounders and machine guns are distributed through the bridges and in the tops. Two 18-inch Whitehead torpedo discharge tubes complete the armament of these very formidable vessels. The ships are protected at the waterline by a continuous belt of armor (and, by the way, all the heavier armor is of the cemented Krupp steel type), which is 9 inches in thickness at the top and 7 inches at the bottom in way of the machinery spaces, and this armor reduces toward the ends of the ship successively to 7 inches, 5 inches, and 4 inches in thickness. The ship's side from the main belt to the main deck is protected, for nearly two-thirds of the ship's length amidships, by a wall of 7 inches of armor, and there are athwartship bulkheads also 7 inches in thickness.

Now, although we consider it unfortunate that Congress should have limited the size of these two particular ships to 13,000 tons, preferring to have seen them of the same displacement and identical in all the features of speed, armor, and armament with the vessels of the "Connecticut" class that are now authorized or under construction, it must be admitted that the Bureau of Construction has turned out a most excellent design on a limited displacement; for the armor protection and the battery power of the "Idaho" and "Mississippi" are, we consider, fully equal to that of any of the largest of the foreign battleships that are at present being built. For their size they are the most effective battleships in the United States navy.



Displacement, 13,000 tons. **Speed,** 17 knots. **Coal Supply,** 1,750 tons. **Armor:** Belt, 9 inches t
Four 12-inch, eight 8-inch, eight 7-inch, twelve 3 inch, twenty

NEW BATTLESHIPS "IDAHO" AND "MISSISSIPPI,"

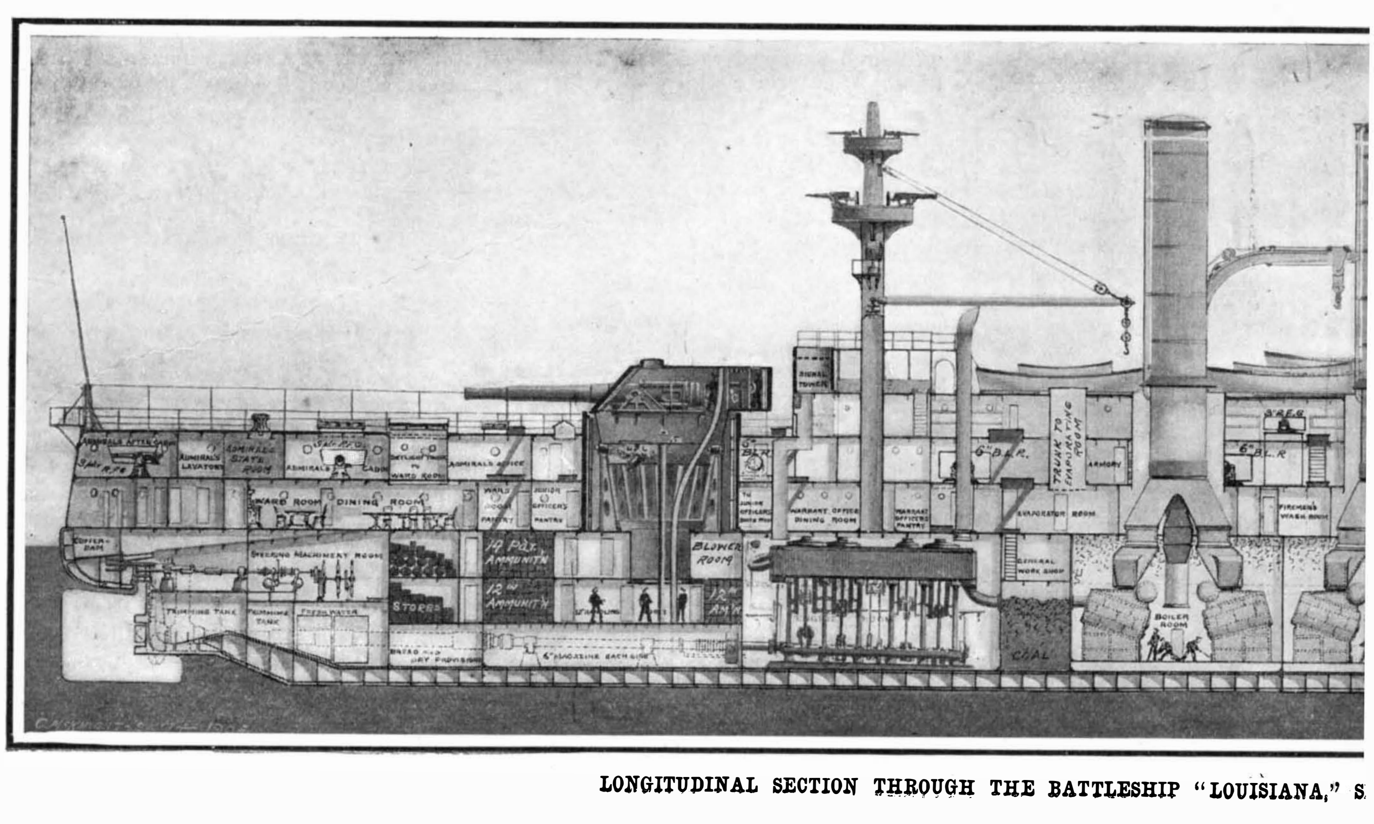
THE MODERN BATTLESHIP WITHIN AND WITHOUT.

On the cover of the present issue we present a striking illustration of the "Louisiana," the latest and largest of the United States battleships, with Admiral Farragut's famous "Hartford" introduced in the offing, to show the changes wrought in the past forty years. In the accompanying cut is shown in detail the interior of the "Louisiana." The ship carries four 12-inch, eight 8-inch, twelve 7-inch guns and a numerous battery of smaller pieces. She has a 12-inch belt, a 3-inch protective deck, and excellent protection for her batteries. Her speed is 18 knots. She is a sister ship to the "Connecticut," which was fully described in our issue of October 1, 1904.

The story of the complicated character of the interior of a modern battleship is one that has grown somewhat stale in the telling, and it is not the fault of the magazine writer and the occasional correspondent of Sunday supplements, if the general public is not satisfied that a great battleship or cruiser is complicated beyond the power of words to express.

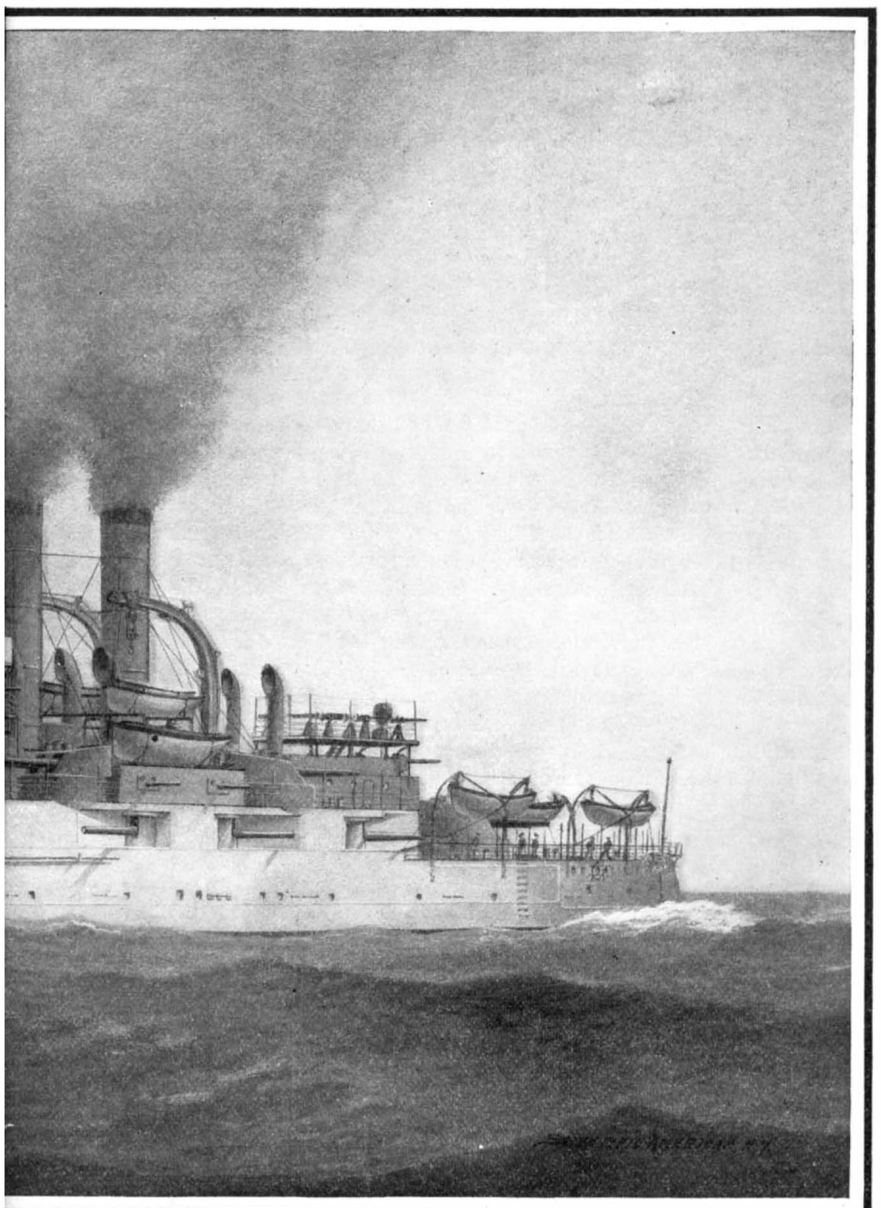
In saying that the battleship is complicated we must be careful to remember that complication does not imply confusion; and that in all the practicable achievements of engineering, it would be difficult, if not impossible, to find a structure which, in spite of the many parts of which it is made up and the enormous elaboration of detail that it manifests, is really so harmoniously proportioned, or is better fitted to the ends for which it was designed. There are some subjects of which an illustration will tell more in five minutes than tongue or pen can explain in an hour; and in presenting the accompanying view of the interior of one of the latest battleships of the United States navy, we shall not attempt to give any elaborate description of the vessel, but will leave it to the diagram to tell its own story.

The drawing is what is known as an inboard profile; that is to say, it is a vertical, central, longitudinal section through the whole length of the ship. The huge structure of which we thus obtain an interior view, is a little under 450 feet in length from the extreme tip of the ram to the end of the rudder. The foundation of the whole is the keel, which is nothing more nor less than a deep plate girder, 3 feet 6 inches in



LONGITUDINAL SECTION THROUGH THE BATTLESHIP "LOUISIANA," S

depth, extending from the inboard end of the ram structure to the rudder post. Bisecting it at every 4 feet of its length occurs one of the plate girder frames or ribs, which extend athwartship, and run up to the under edge of the armor shelf, where they are reduced to a depth of say from 12 to 18 inches, the frames extending up the sides of the ship to the level of the

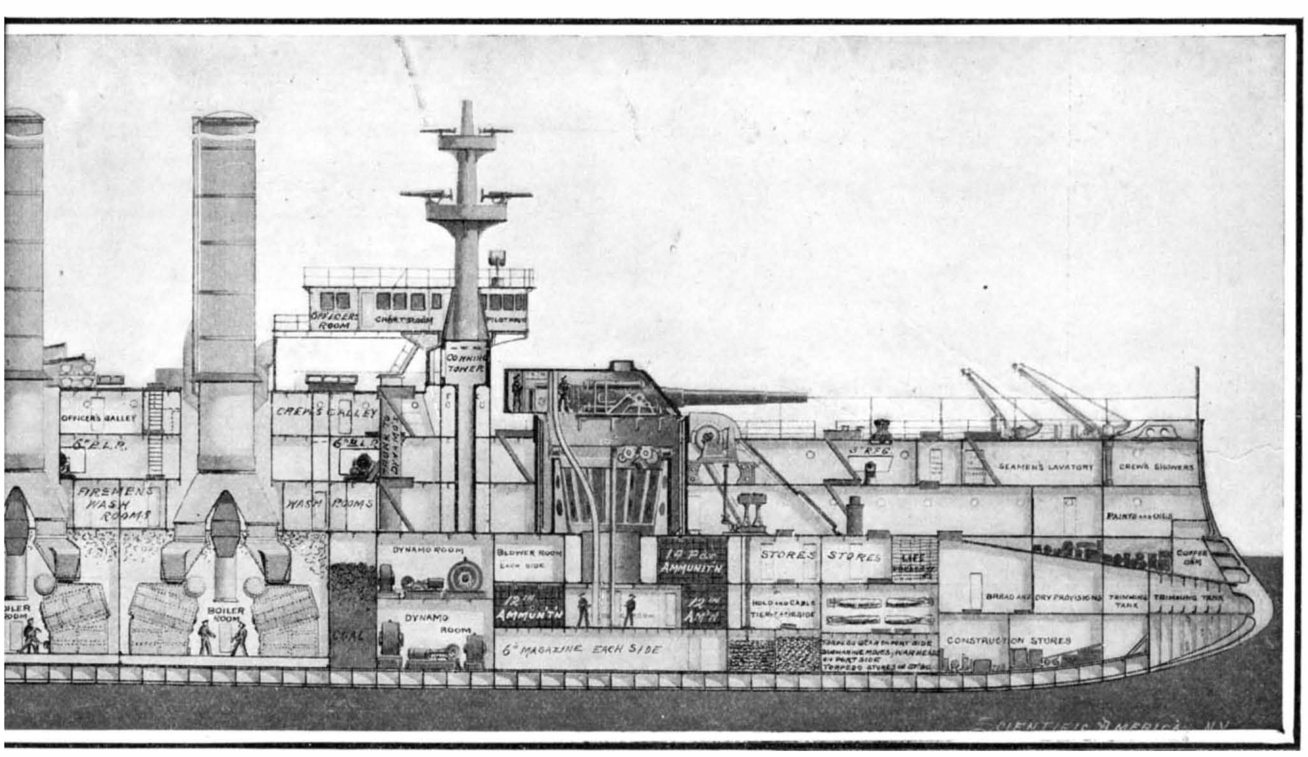


4 inches; Deck, 2½ inches; Main turrets, 12 inches; Secondary turrets, 6½ inches. **Armament:** smaller guns. **Torpedo Tubes,** 2 submerged.

NOW BUILDING FOR UNITED STATES NAVY.

upper deck. On the outside of these frames is riveted the outer plating of the ship, and upon the inside of the frames, extending as high up as the under side of the waterline belt, say 4 or 5 feet below the waterline, is riveted an inner shell of plating. The space between the outer and inner plating is divided up by the frames into transverse water-tight chambers 4 feet in width, and every one of these spaces is subdivided by seven or eight longitudinal plate girders which are built into the double bottom, as it is called, parallel with the keel and extending, most of them, the entire length from stem to stern. Consequently it will be seen that the space between the outer and inner shells of the ship's bottom is divided into a great number of compartments, measuring 3½ feet in depth by 4 feet in length by about 6 feet in width. These compartments are absolutely watertight. Above the inner floor or platform the central portion of the vessel is taken up by the magazines, boiler rooms, and engine rooms. These, because of their vast importance, are known as the ship's vitals, and great care is taken to protect them against the entrance of heavy projectiles of the enemy, and, as far as may be, against the attack of the still more deadly torpedo. The engines and boilers are so proportioned as to height that they do not extend above the waterline; and to protect them from plunging shot, or from the entrance of the fragments of heavy, high-explosive shells, bursting within the ship above the waterline, a steel deck, 2 to 3 inches in thickness, known as the protective deck, extends at about the level of the waterline over the whole of the vitals, and is continued in a gently curving slope to the ram forward and to the stem aft. In the vessel here shown this steel deck is 1½ inches thick on the flat and 3 inches thick on the slopes.

Now, the space below the protective deck is divided up by a large number of transverse, water-tight bulkheads of steel plating, there being nineteen of these bulkheads altogether. They extend from the inner shell of the vessel to the under side of the protective deck. They are riveted perfectly water-tight, communication from compartment to compartment being by water-tight doors. Forward in the bow are the trimming tanks, used to assist in bringing the vessel to an even keel. Then abaft of the collision bulkhead are bread and dry provision stores, and the construction stores. In the next compartment, which is divided into three decks, we have on the floor of the ship a storeroom for torpedo gear, submarine mines, etc. Above this is the underwater torpedo room, and immediately below the protective deck are kept the paymaster's stores and life preservers. In the next compartment, below on the platform, are the anchor gear and chain lockers, and above this the navigator's stores. Passing through the next bulkhead we come to the vitals of the ship proper, with the 6-inch gun magazines on the floor, the 12-inch magazines and handling rooms on the deck above, and above this the 14-pounder ammunition and blower rooms. Above the magazines, and resting on the protective deck, is the barbette of the forward pair of 12-inch guns, the armor and its relative thickness being shown by heavy, black lines; while in front of the barbette the heavy sloping black line indicates the athwartship sloping bulkhead, placed there to prevent raking projectiles from passing through the entire structure of the ship.



HOWING THE INTERNAL ARRANGEMENTS OF A MODERN WARSHIP.

Immediately to the rear of the forward barbette is seen the conning tower, with the heavily armored tube which protects the telephones, electric wires, voice tubes, etc., that pass from the tower down below the protective deck. In the next compartment, aft of the magazines, are the dynamo rooms; and then between the next two bulkheads is placed an athwartship coal bunker. A similar coal bunker extends athwartship on the other side of the boiler rooms; and it must be understood that at the side of the boiler rooms are the wing bunkers which run aft for the whole length of the boiler rooms and engine rooms. The boiler installation on this particular ship is entirely of the water-tube type, and it consists of twenty-four units arranged in six separate water-tight compartments, three on each side of the center line of the vessel. Aft of the boiler rooms comes the athwartship coal bunker above referred to, and then in two separate water-tight compartments are the twin-screw engines. Aft of the engines in another compartment is contained a complete set of magazines similar to that beneath the forward barbette, and above them, resting on the protective deck, is the after barbette and turret, with its pair of 12-inch guns. Aft of the magazines come more compartments, devoted to stores. In the next compartment, down on the platform, are the fresh-water tanks and two trimming tanks, and on the deck above, below the protective deck, are, first, the steering-machinery room, and then the steering-gear room, each being in a separate water-tight compartment. This completes the description of the space below the protective deck.

The protective deck is known more generally among seamen as the berth deck. Above that, at a distance of about 8½ feet, comes the main deck, and 8½ feet above that the upper deck, while amidships, between the two main turrets, is the superstructure, the deck of which is known as the superstructure or boat deck. The berth deck and main deck are devoted to the living accommodations of the officers and crew, the crew being amidships and forward, and the officers aft. The berth deck, as its name would indicate, is largely devoted to the berthing and general living accommodation of the crew. Here are also to be found, in the wake of the forward gun turrets, on one side the sick bay, and on the other side the refrigerating room and ice machine. Aft of that, on the port side, are the sick bay, lavatory, dispensary, machinists' quarters, ordnance workshop and blowers; while on the starboard side are the petty officers' quarters, the laundry, and the drying-room. Then, in the wake of the boiler-rooms, on each side of the ship, are coal bunkers which add their protection to that of the side armor of the vessel. In the center of the ship are washrooms for the crew and firemen. Aft of the coal bunkers on this deck come the officers' quarters. On both sides of the ship are the staterooms of the junior officers, and the wardroom staterooms, while between them is a large wardroom and dining-room with its pantry. The extreme aft portion of the berth deck is taken up by officers' lavatories, etc.

On the main deck above, forward, is more berthing accommodation for the crew, also shower baths and lavatories, while amidships are found the various galleys for the crew and the officers, arranged between the base of the smokestacks, while amidships in the wings of the vessel is more berthing space for the crew. Aft on the main deck the space is given up largely to accommodations for the senior officers and for the admiral, which, by the way, give one an impression more of commodiousness than of rich or extravagant furnishing. Forward, above the conning tower, are the pilothouse, chartroom and the room of the commanding officer. In the particular ship shown, the heavier guns are mounted on the upper deck, two 12-inch guns in a turret forward and two aft, and eight 8-inch guns in four armored turrets, two on each broadside amidships. The intermediate battery of twelve 6-inch guns is mounted on the main deck, the guns firing through casemates. On this deck are also eight 3-inch guns, four forward and four aft; there are also four 3-inch guns, mounted in broadside on the upper deck, within the superstructure. The new method of emplacing guns on our warships, by which it is possible to swing the guns around until their muzzles are flush with the side of the ship, has the good effect of leaving the side of the ship free from projecting objects when the vessel is in harbor, and of leaving the living spaces of the crew but very slightly obstructed.—Reprinted from 'Scientific American Reference Book" of 1905.

According to the recently published statistics of the Milan Association of Silk Manufacturers and Merchants, there are at the present time 1,065 silk spinning mills in Italy. Of this number 346 are silk throwing factories, with 705,262 spindles at work, and 49,050 idle; 165 silk weaving factories, with 9,703 hand looms at work and 159 idle; and 7,459 machine looms at work and five idle. Silk manufactories are found in nearly every part of Italy, but the principal centers are in the provinces of Piedmont, Venice, and Lombardy. Machine looms are to be found only in Piedmont and Lombardy.

THE HOW AND WHY OF THE MODERN KEYBOARD.—I.

BY THE REV. F. W. GALPIN, M.A., F.L.S.

In the wide range of musical instruments none are more popular or more practical than those provided with a keyboard; and although, as was shown in a recent paper on the Roman water organ, the modern keyboard is a comparatively recent invention, yet more than seven centuries have rolled by since its first introduction, or rather its reintroduction in mediæval times. We purpose to describe in brief the how and why of this adjunct to our music-making, and we begin with the organ, for it was to this instrument the keyboard was first applied. The illustrations accompanying this article represent types to be found in the splendid educational collection donated by Mrs. J. Crosby Brown to the Metropolitan Museum of Art—which has been so scientifically arranged that it is one of the finest of its kind.

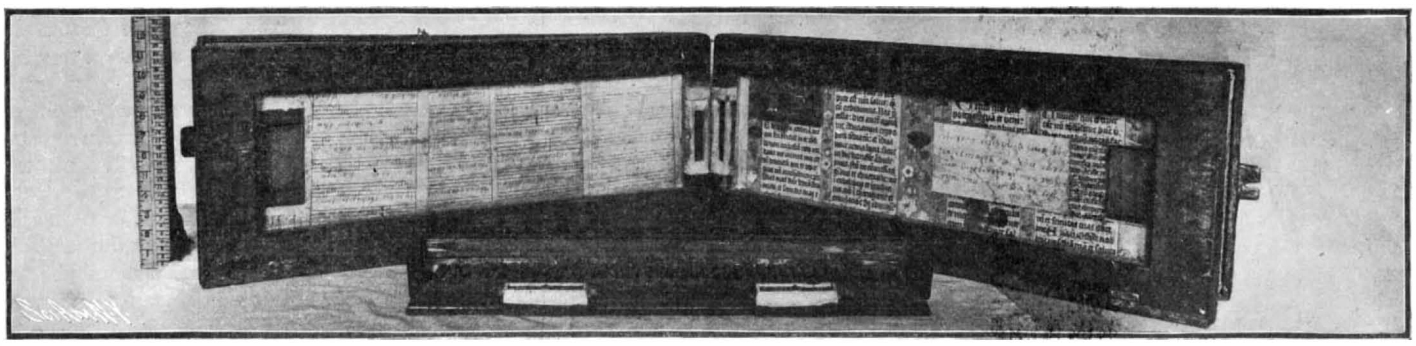


Fig. 4.—A Folding Regal of the Sixteenth Century.

For the loss of the knowledge of the keys of the hydraulus or water organ with their tones and semitones and their light "touch" we have already suggested some possible reasons. When the organ re-appears as an aid to purer worship it is a pneumatic and not a hydraulic instrument. Keyboard there is none; but the player pulls a perforated slider called in the old manuscripts a "lingua" or tongue, which is placed under each pipe or set of pipes and marked with the names of the notes represented. An organ of the eleventh century thus constructed is shown in Fig. 1, taken from an old version of the Scriptures. In the monastic church of Winchester, England, such an organ was erected toward the close of the tenth century, and in a Latin poem written to celebrate this great work we are told that "two brethren of concordant spirit sit together at the instrument and each controls his own alphabet," an allusion to the lettered sliders.

At the beginning of the twelfth century, however, we begin to hear of keys—small levers which when depressed push in the wooden sliders and when released were restored to their original position by means of a horn spring; in fact they were very similar to the key-levers described by Hero of Alexandria some fourteen hundred years before. The flat "touches" of the levers, called "lamina," were now marked with the letter of the note to which they corresponded and hence arose the name "key" (*clavis*) because the letter gave the "clue" or "key" to the particular sound required. This practice of lettering the keys was long continued, appearing even in the spinet and virginals of the sixteenth and early seventeenth centuries. The use, however, of levers and sliders as organs grew in size was found exceedingly cumbrous, and it soon yielded to an invention which was destined not only to survive to our own day, but to revolutionize the keyboard and bring it to its present effective form.

Organs of diminutive size, called "*portatives*" because they could be carried by the performer and played as he went, had in early times been constructed, and these were furnished with valves (technically called "pallets") for admitting the wind to the pipes instead of with slides. At first a small T-shaped button, somewhat like those of the concertina, when pressed by the finger opened a hinged valve placed directly below it and kept in place by a little spring; this allowed the wind to pass through a small channel to the pipe standing just behind the button. Such a rudimentary keyboard is shown in a painting by Mellozzo da Forti (c. 1450) in the National Gallery, London, a survival, doubtless, of an older day. For before this the little buttons had been covered with thin slips of wood hinged at the further end and forming the keyboard which is found in all the smaller organs of the sixteenth and seventeenth centuries. Turning to the interesting and valuable collection of Mrs. J. Crosby Brown in the Metropolitan Museum of Art we find among the numerous specimens there gathered a great many that will serve to illustrate the subject in hand. In Fig. 2 a portative organ is shown and it will be noticed that the pipes stand in two rows immediately behind the keys. This is still more clearly seen in Figs. 3 and 4, which give two forms of the rare instrument known as the *regal*. In the first instance we have the ordinary form with large bellows worked alternately to supply the wind to the small "reed" pipes, the ends of which are seen projecting in a double row in the space between the bellows and keyboard. The other instrument is the folding or Bible regal invented by G. Voll in 1575. The principle is the same and the ends of the little pipes are distinctly visible, but the whole of the pipes and keyboard mechanism can be packed away inside the bellows-case, which, when closed, was often designed to give the appearance of a large book. Another and later form of book organ is shown in Fig. 5. An old *positive* organ is represented in Fig. 7. This name was given to the larger form of the small organs because it had to be placed in position before it could be played on. It was in a certain sense portable, and the reader will observe the iron bands through which the carrying poles were put; here, too, the little pins which opened the valves of the earlier organs are lengthened into long wooden "stickers" communicating the action of the key to the valves placed at the bottom of the case. The two straps projecting from the right-hand side are for raising the bellows.

Fig. 1.—Organ with Sliders. (Eleventh Century.)

Now the application of the valve or pallet to the larger organs probably took place during the early part of the thirteenth century. The mechanism, however, required some alteration, as owing to the absence of any means of silencing the various rows of pipes, such as the later ventils and the stop sliders, it was necessary that every pipe should be furnished with a valve. A stout rod of wood, therefore, was placed beneath the pipes in each row which were to be sounded together and the pallets were attached by cords to it. As the rod was hinged at the further end, on depressing the nearer end the cords pulled the pallets open, and, when it was released, strong springs closed them again. So great was the force required to open the pallets that the ends of the rods were struck with the closed fist and the performer was aptly called "the organ-beater." In Praetorius's "Organographia" (plate xxv.) we find an illustration of such keyboards attached to the old organ at Halberstadt, erected in 1361, and in the light of later developments it is interesting to observe that it possessed three manuals for the hands and a small pedal-board for the feet. In these old organs the keys varied from 2½ to nearly 6 inches in breadth because the lower key had to represent the diameter of the largest pipe which stood immediately behind it and the size of this key regulated that of the rest. In the fourteenth century, however, an important improvement was made—wooden rollers were used to transmit the action of the key in any direction right or left; the size of the keys, therefore, was no longer dependent on the size of the pipes, for the latter could be placed on either side of the organ so long as they could be reached by the rollers and their "pulldowns" or "trackers." Owing to this invention we find that in the organ built for the church of S. Aegidius, Brunswick, in 1456, the keys were so reduced in size that a fifth could be struck with the thumb and little finger, and in 1499 an organ was constructed for the same city with a keyboard whose octave was only one note longer than at present. In the following century the width was further reduced and became identical with the

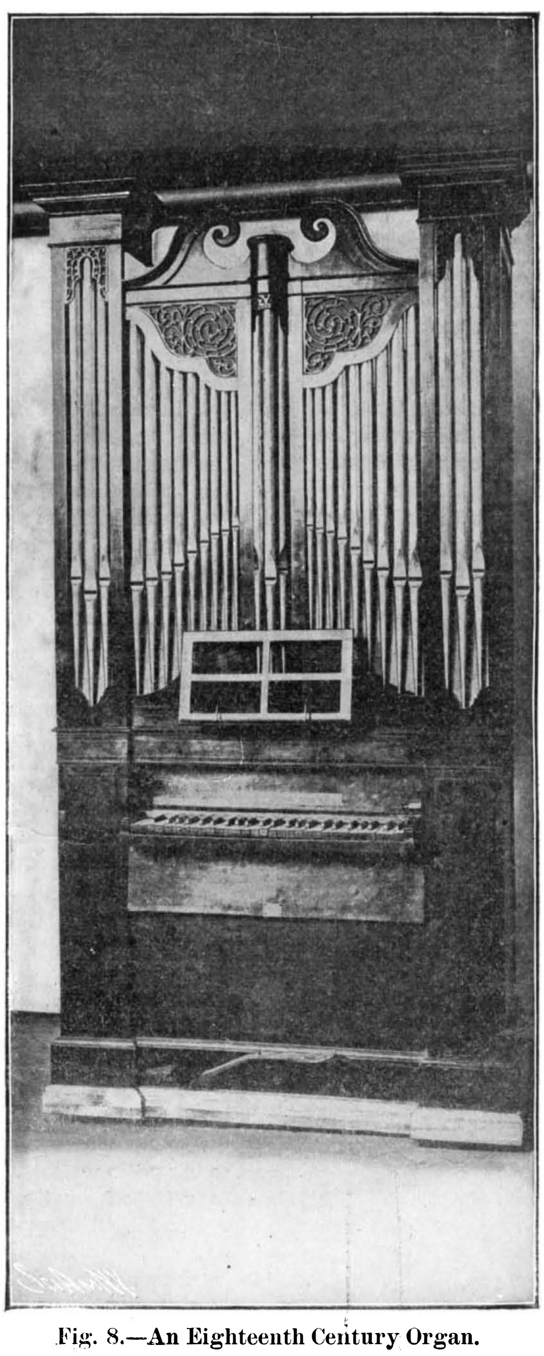


Fig. 8.—An Eighteenth Century Organ.

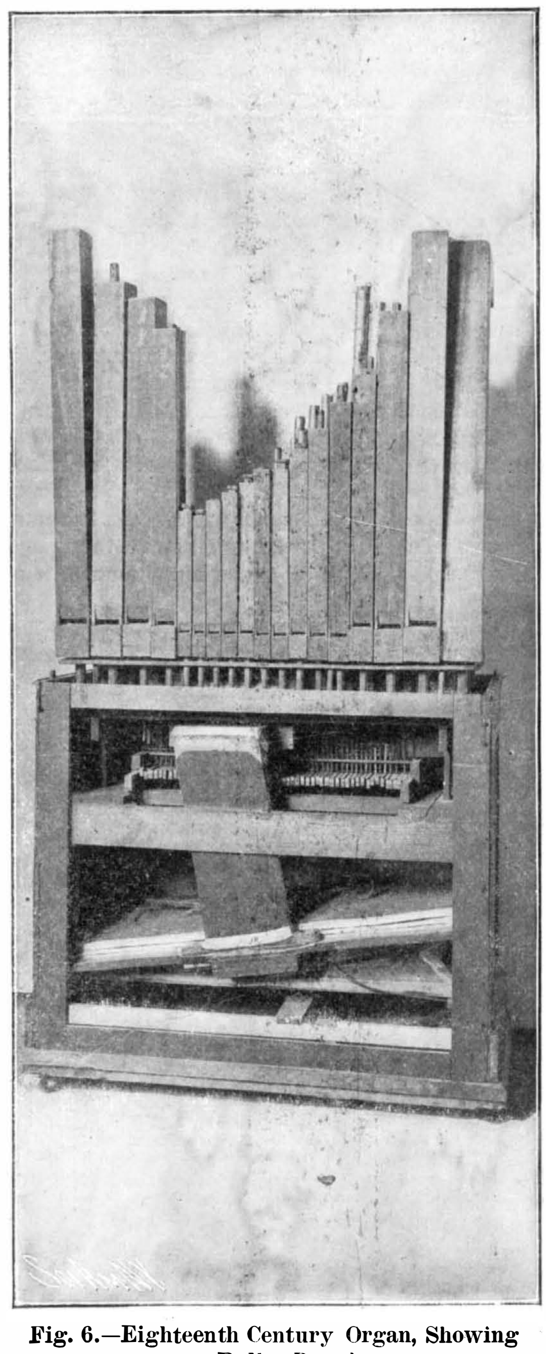


Fig. 6.—Eighteenth Century Organ, Showing Roller-Board.

THE HOW AND WHY OF THE MODERN KEYBOARD.—I.

keyboard of the virginal and harpsichord, of which we propose to treat in a subsequent paper. The use of the tracker and roller-board in an organ of the eighteenth century is seen in Fig. 6. Here the pipes are no longer placed exactly behind their respective keys; and to the present day this mechanism is in general use for ordinary organs, though tubular-pneumatic and electric systems have dispensed with most of it in the larger instruments. Our present keyboard

Fig. 5.—Book Organ.

is chromatic, but as will be noticed in Fig. 1, the oldest organs were diatonic, though B♭ was sometimes admitted for the sake of the Gregorian tonality At Florence the writer was recently told by an organ-builder of a small organ which had come into his possession from a convent in which the keyboard had no sharps or flats; to his shame be it said that he had broken up this valuable relic of the olden days for firewood! The first accidental to be admitted after the B♭ was the F♯, then followed C♯ and E♭ and lastly G♯, but in the lowest part of the keyboard the sharps and flats were for a long time frequently omitted, and in Fig. 8 is represented an organ of the eighteenth century with the lowest C♯ wanting. Of the how and why of this we speak hereafter.

(To be continued.)

Madame Curie's Youth.

From the most recent accounts it would indeed seem that we are not a little indebted to the parsimony which the Minister of Public Instruction, in Russia, injected into the appropriations allotted to the experimental studies in the colleges, for the marvelous discovery of radium. Mr. Roussakov, a compatriot of Mme. Curie, gives, in the Novosti of St. Petersburg, some curious details of her youth, as well as interesting facts concerning her first initiation into the mysteries of her father's physical laboratory.

Mr. Roussakov was a pupil of Mr. Sklodovska, professor of physics at Warsaw in the Second College or "gymnasium" as the Russians call it, and it was in this building that the future Mme. Curie was born. Prof. Sklodovska was imbued with a passionate love for science; he was ready to make any sacrifices for its sake, he gave without stint his time, his energy, and his money to its cause. In spite of his strictness all of his pupils adored him, because they recognized in him a rare quality—at all events rare in Russia—the desire to infuse into his classes the love which he cherished for the branch of science which he taught.

Prof. Sklodovska classed physics among the experimental sciences. With him theory occupied a secondary place. Literally, he never allowed a lesson to pass without improving the opportunity to perform some experiments before his pupils, and he constantly deplored the paucity of the resources at the disposition of the school laboratory. Even the most essential apparatus were wanting, not to mention the funds to procure the materials consumed.

The pupils themselves were constant witnesses of the disputes that raged between Prof. Sklodovska and Mr. Chmourlo, professor at the Lyceum or classical branch of the college.

Mr. Chmourlo was such a biased partisan of the study of the classics that he considered the experiments in physics but child's play, useless amusement, and deemed the meager sums allotted to the maintenance of the laboratory as more than sufficient.

The pupils of Prof. Sklodovska became all the more attached to him after they learned that their beloved master levied upon the very modest stipend that Russia allowed her professors, to obtain the wherewithal to cover the expense of the experiments and furnish his cherished laboratory. Every leisure moment was passed in his physical room; every mundane pleasure was strictly eschewed.

Where the proper implements were wanting it could hardly be expected that funds would be at command to pay an assistant, whose duty it should be to keep things in order, to do the drudgery, wash the tubes, retorts, and alembics after the experiments, and such unskilled labor. This thankless task was assumed by the little daughter of Prof. Sklodovska, who had evidently inherited the passionate fondness of her father for science. The paternal laboratory served her as a nursery, and the test tubes and ampullæ or flasks supplied the place of dolls. Of a serious turn and developed beyond her age, she passed entire days in the laboratory. Protected by a large apron and provided with towels, she hustled here and there, setting things in order and keeping them in the pink of neatness.

She seemed to know intuitively the proper place for each article, to feel, as it were, just what was needed for each experiment, and could even describe the various processes.

It was evident to the pupils visiting the classes that this little girl, with her precocious intelligence, exerted herself to penetrate into the hidden meaning of the ideas her father let fall as crumbs during the lecture. On the other hand, the professor adored his little daughter, but considered her work in the laboratory only as a pastime, an amusement, never suspecting that in this early taste for the management of a laboratory there could exist the germ of a future scientific career. Wiser than he were the almost idolatrous followers, for they dubbed the helpful little maid *professorowna.* The time came when Mlle. Sklodovska must go to school; nevertheless she did not give up her attentions to her dear laboratory. At the moment she became free from her lessons she rushed to the scenes of her chosen labors, where the tubes, retorts, alembics, flasks, pumps, and other implements lay around helter-skelter awaiting her arrival.

She soon had everything orderly, arranged in its proper place, and in the evening returned with her father to assist him in preparing everything that was necessary for the experiments of the coming morrow.

It often happened on these occasions that she had an opportunity to hear the whole lecture, for her father had the habit of giving a *résumé* of the course.

Little by little the *professorowna* developed from the simple assistant without remuneration into an adequate aid to the professor, particularly when the father, beginning to feel the burdens of age, felt the need of some one to prepare the implements for the lecture.

Along with her regular studies at the "gymnasium" Mlle. Sklodovska continued her labors of love beside her father in the laboratory.

The pupils of the professor, even after they had passed their examinations and entered into real life, never forgot the youthful *professorowna.* It was no surprise to them to learn that she too had passed a brilliant examination and, sacrificing everything for her love of physical science, had left Warsaw for Paris, where she could better complete her studies. There can scarcely be a doubt that had the Russian government been more liberal toward the maintenance of the physical laboratories in its colleges, Prof. Sklodovska would never have taken the care and trouble to initiate his daughter into the secrets of science at so tender an age. What strikes us most in this short notice of the youth of Mme. Curie is that if the civil law permits the daughter, as it does her brother, to take

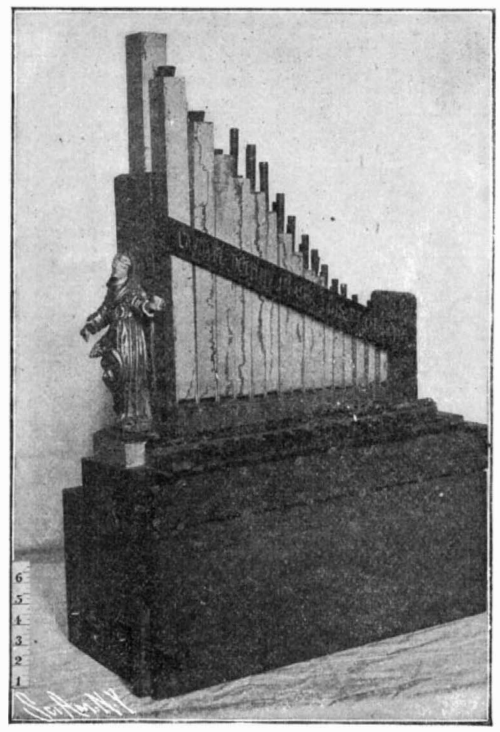


Fig. 2.—Portative Organ.

possession of the heritage of her father, the laws of nature endow her with the same rights regarding the intellectual heritage.

It is much to be regretted, however, that in most cases the fathers exclude the daughters from this portion of their succession, for which many times they are more fit than the sons. Fortunately Prof. Sklodovska was not of this caste, however, and by proceeding upon a path marked out rather by necessity than by choice he has given to the world the discoverer of radium.

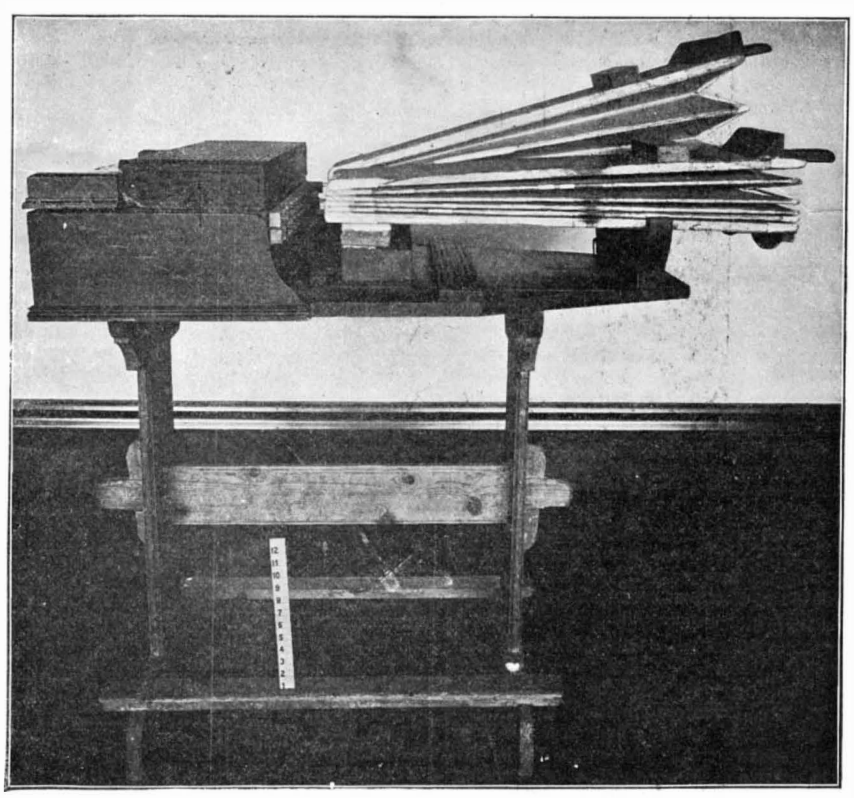


Fig. 3.—Large Regal (Seventeenth Century).

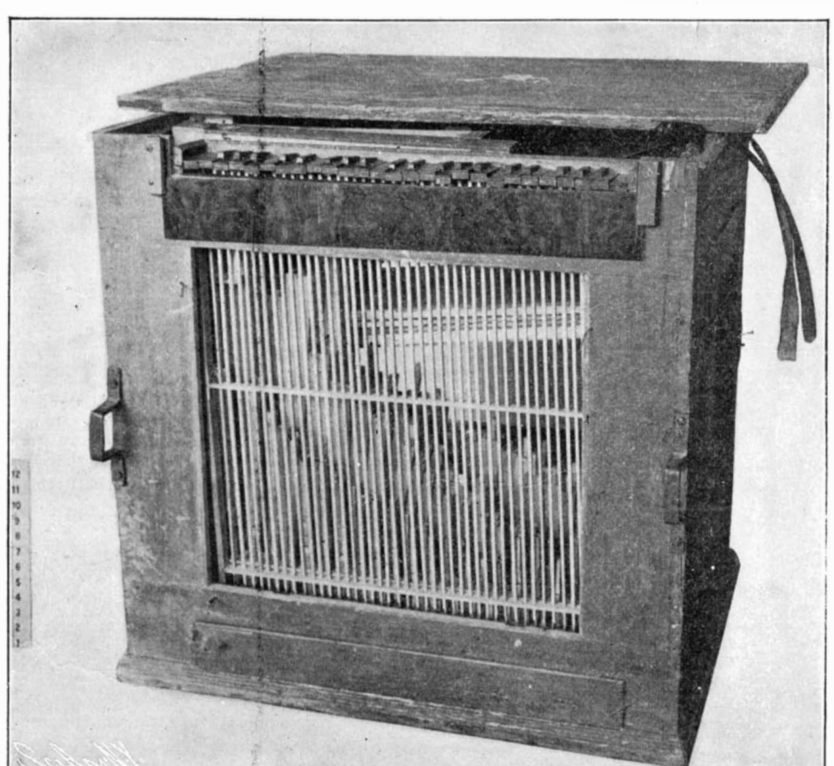


Fig. 7.—Portative Organ (Seventeenth Century).

THE HOW AND WHY OF THE MODERN KEYBOARD.—I.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

ELECTRICAL CABLEWAY-CONVEYER.—C. Messick, Jr., Hackensack, N. J. The inventor's purpose is to provide a telpher traveling the required rate of speed, about six hundred feet per minute. The device is provided with grooved wheels having a good bearing-surface on the cable being driven by an electric motor of normal speed and to provide a pivot near as possible to the level of the track which will allow the telpher to accommodate itself to vertical variation, especially in a cable-track, due to its only having supports at intervals, without causing the load to sway longitudinally as the telpher ascends in approaching and descends in receding from a support.

Of Interest to Farmers.

CULTIVATOR.—J. E. Spraggins, Bearcreek, Ala. The object of the invention is to produce a cultivator of simple construction the hoes or blades whereof may be adjusted in a simple manner. The improvement is especially applicable in a construction of cultivator involving the use of three hoes, and a further object is to provide an arrangement for attaching a centrally-disposed hoe.

TONGUE-SUPPORT.— . W. Hartwig, Taylor Station, Wis. This support is for tongues of mowers, self-binding harvesters, threshing-machines, and other farm machinery; and the object is to provide a support readily applied, and adjustable to hold the tongue in a proper position relatively to animals drawing the machine, so as to prevent undue strain on their necks, and thereby avoid sores, fatigue, etc.

COUPLING.—J. W. Buller, Jansen, Neb. In this patent the invention relates particularly to improvements in couplings for attaching a traction-engine to a device to be drawn—such as a threshing-machine, separator, tender, wagon, or the like—the object being to provide a coupling that will automatically move to and lock in closed position.

Of General Interest.

THEATER-CHAIR.—E. H. Wierschinc and C. J. Bergstrom, Binghamton, N. Y. The chairs are normally held in rows as usual and the seats are normally held close to the backs of the chairs by tension devices. The chairs are constructed so that at option of an occupant a latch may be operated, whereupon a spring in the pedestal will act to give the body a quarter-turn, bringing it at right angles to normal position, thus opening one row into the next, and when all in the rows of a section are thus operated series of aisles are obtained, enabling persons to find easier exit from a theater or hall than when ordinary chairs are used.

SIPHON-FILLING APPARATUS.—L. P. Setzler, Kansas City, Mo. This is a device for charging siphon bottles with carbonated liquids, and it comprises a peculiar valvular mechanism which upon being engaged by the nozzle of the siphon opens the supply of liquid allowing it to flow through the siphon in through the bottle, and upon relaxing possession of the nozzle on the valvular mechanism the liquid supply is automatically closed and the vent previously closed by the pressure of the siphon nozzle is thereupon opened to allow the escape from the nozzle of the "sniff" or waste liquid lying in the nozzle outward from the siphon valve.

COMBINED TRUNK AND DESK.—T. McCabe, Jr., Homestead, Pa. The object in this instance is to provide a device in which a trunk will serve the usual purposes and having an attachment that may be used as a writing-desk, a drawing-board, a reading-table, or the like, the attachment being so arranged as to fold into the trunk when not in use, thus resulting in economy of space.

FISH-HOOK.—W. E. Koch, Whitehall, N. Y. The hook is particularly adapted for using dead minnows as bait, although live bait may be used with it. The object of the invention is to provide in connection with the hook a simple means for keeping the bait in proper position to simulate a live minnow—that is, with the back up when drawn through the water.

DENTAL DILATING-FORCEPS, OR APPLIANCE FOR DENTAL OR SURGICAL USE.—G. H. Parsons, East St. Louis, Ill. Dr. Parsons' invention is an appliance or implement adapted for use in distending the mouth to facilitate inspection and the performance of dental and surgical operations. It is particularly useful in taking impressions of the jaws, and especially of aged persons; in setting gold crowns; and for surgical operations on the jaw and throat. It aids every operation in the oral cavity, such as disease of the antrum or extraction of wisdom-teeth under chloroform, also in removing tonsils or filling teeth.

BANK-CHECK, RECORD-BOOK, AND BINDER.—M. A. Howe, Tacoma, Wash. The objects of this improvement are, to provide a more economical, systematic, and convenient form of bank-check and record-book than the stub-book form now commonly used; to provide a bank-check-record book and a bank-check book separated from each other, but within one binder, and to provide a detachable binder for a bank-check-record book and check-book together within the one binder.

SPOOL ATTACHMENT.—Fanny G. Hendryx, Springfield, Ohio. In this patent the invention has reference to attachments for spools, having for its principal objects the prevention of waste of thread and the furnishing of means for retaining the spool against rolling upon surfaces upon which it may be placed. If the spool is loose, as in a work-basket, the thread cannot be accidentally unwound.

FLUSHING DEVICE.—A. C. Davidson, Chicago, Ill. This improvement relates to flushing devices, and more especially to devices controlled by movable foot-plates operatively connected with valves for controlling the flow of water or other flushing liquid. One object is to provide a device of this type which will be nearly automatic in action, being set in operation by the pressure of the feet of a person standing near the basin or hopper to be flushed, and which will act automatically to cut off the flow of water when pressure upon the foot-plate is removed.

NAVAL ARCHITECTURE—G. F. R. Blochmann, Kiel, Germany. No armor has been discovered which will effectually protect marine vessels against the disastrous effects of submarine explosions. Such protection becomes more necessary as the weapons for under-water attack, such as fixed and movable torpedoes and submarine boats, become more highly developed and effective for offensive work. The invention consists in giving to the ship several (at least two) complete walls or bottoms under water, of which, however, not the outer skin, but perhaps one of the inner skins, may be armor-clad.

APPARATUS FOR MAKING SHEET-GLASS.—J. P. Taylor, Cicero, Ind. In carrying out this invention Mr. Taylor has particularly in view an apparatus for forming the glass sheet so that both sides of the latter will be polished to the same degree. A further object is to provide means whereby the molten glass may be easily and readily conveyed to and deposited on or in a form of table or carriage arranged adjacent to the receptacle carrying the molten glass. Further an object is to force the molten glass from the receptacle through the medium of a charge of air or steam or any gas, and further in view means for forming a cushion of air or steam in the receptacle or table for the sheet, such molten sheet being supported in its formation by the cushion of air, steam, or any suitable gas or vapor.

VIOLIN WRIST-BRACE.—J. W. Smith, Wellington, Kan. This invention has reference to a brace for the wrist when playing the violin; and the objects of the improvement are, first, to provide a medium to assist the pupil in obtaining the correct position of the wrist while playing the violin, and, second, to afford facilities for executing the shake.

CLIP FOR FASTENING SHOE-LACES.—R. J. H. Hughes, Duquesne, Pa. The general object of the invention is to provide an inexpensive clip which may be quickly applied to shoe-laces, which will hold the laces with perfect security, so doing away with the necessity of tying them in a knot in the ordinary manner, and which may be easily loosened to permit the unlacing of the shoes when desired. The invention may be used for fastening other cords.

MEASURING INSTRUMENT. — L. M. Hodge, San Jose, Cal. The invention relates to measuring instruments such as shown and described in a prior Letters Patent of the United States granted to Mr. Hodge. The object is to provide an instrument upon which is conveniently arranged the lengths, bevels, and cuts of rafters, hoppers, etc., and arms upon which any two of said bevels can be taken at the same time, together with their degree of pitch.

CASKET-CATCH.—L. Greensides, Constantine, Mich. This catch is attached to the cover of a casket and co-operates with a bar, attached to the main part of the casket. The bar is provided with an opening for reception of a tongue and with a projection to enter the opening. When the cover is placed upon the main body of the frame and the tongue and the projection thrust through the openings, the casket parts will be locked together, as the projection prevents motion in one direction, while the tongue prevents upward and forward motion. Means are provided by pressing a projection to readily remove the cover.

GARMENT-FASTENING.—M. W. Ferris, New York, N. Y. One purpose of the invention is to provide a supporting device with means for attachment to a tab, strip, tape, or the like and with end bearings or hangers for the free passage of a safety-pin attachment of any desired type, which bearings will afford a uniform and firm support for the pins effectually preventing displacement of the pin or any injurious or inconvenient twisting action. This device is adapted for use especially in connection with hose-supporters or like articles.

INDICATOR.—F. J. B. Cordeiro, New York, N. Y. This invention relates to devices for indicating the time at different points upon the earth's surface, and has for its principal object the provision of such a device from which the desired information may be readily obtained without special computation. The indicator is set instantly and the times read therefrom without difficulty. It is of great utility for educational purposes to clearly illustrate relation of time and longitude and to business houses to regulate such transactions as sending of cablegrams.

CLOTHES-LINE HOLDER AND TIGHTENER.—C. W. Ott, Pittsburg, Kan. The purpose of this improvement is to provide a form of holder and tightener that will serve as a convenient reel that may be carried about in the hand and also that may be removably attached to a bracket secured to a post or the side of a building and which, further, has a means for retaining the line taut when set up on the poles and drawn tight.

Household Utilities.

TABLE.—W. H. Gibbes, Columbia, S. C. The invention relates to improvements in tables or desks, the object being to provide a table or desk with a longitudinally-movable top, making it particularly useful for bookkeepers, draftsmen, or others, inasmuch as the top, with a large book or drawing-paper thereon, may be moved along to bring the work into proper position for the person sitting at the table, thus obviating the necessity of shifting his seat.

ANIMAL-TRAP.—W. . Harden, Quitman, Ga. The trap is adapted especially for catching rats and mice. The object of the invention is to produce a trap which is sprung or shut automatically by the animal on entering. It comprises a removable cage or auxiliary body which the animal enters after the trap is shut. Automatic arrangement is made for resetting trap by the weight of the animal after it has passed into the upper body or cage.

TRAVELING ROCKING-HORSE.—A. Hettel, Rochester, N. Y. In this patent the invention has reference to improvements in traveling rocking-horses, the object being to provide an amusement device of this character of novel and simple construction, so arranged as to move forward, turn laterally, or to rock without forward or lateral movement.

Machines and Mechanical Devices.

TYPE-WRITING MACHINE.—J. D. White, 50 Clanricarde Gardens, London, England. Mr. White's objects are to provide a machine to afford three times the range of characters afforded by his machine of prior patent. He accomplishes this by modified form of the machine, the arrangement being that three characters follow successively through each longitudinal row on the type-cylinder and individually brought into action by giving the cylinder a regulated sliding movement along the axle, with which it revolves, and by providing devices by which the cylinder may be slid from one of three positions to the next after each printing or spacing stroke and may be so slid by a further independent movement of printing or spacing.

LUBRICATING DEVICE FOR JOURNALS.—J. J. Moss, Chicago, Ill. The object here is to provide a device more especially designed for lubricating the journals of car-axles and like devices and arranged to insure a continuous supply of the lubricant to the journal or other part to be lubricated, to prevent waste of the lubricant by leakage from the oil-retaining vessel, to render the journal completely dust-proof, and reduce to a minimum the jar incident to the running of the journal in the box.

DRIER.—T. Andrews and S. J. Loewenthal, Rockaway, N. J. This drier is particularly designed for drying fabrics of that class having a series of rotary cylinders through which the heating medium, such as steam, is intended to pass. In machines of this character the cylinders are rotated through gear connections one with another, and owing to the friction, very great power and large amount of motive agent is required to operate the machine. Further, these cylinders must be filled with steam, which results in waste by using more steam than is necessary for drying purposes. The object of the inventors is to avoid the above objections.

MACHINE FOR SWAGING HEADS ON NAIL-BLANKS.—E. Perkins, St. John, New Brunswick, Canada. One of the principal objects of this invention is the provision of simplified and effective and reliable devices for upsetting or swaging the heads on horseshoe-blanks, which are fed to such devices in the form of a bar or wire previously rolled to constitute a continuous coil or length of blanks connected together head to point successively.

CHEESE - CUTTER.—B. Blood, Coeur d'Alene, Idaho. In operation if the operating-lever be in position and it is desired to cut from a cheese weighing, say, thirty-two pounds a slice of one pound a cut may be made through the cheese, the knife raised, and the lever be then moved to the right, when the cheese will have been moved from the initial cut an extent necessary to provide a slice of one pound, and the slices may be cut successively of any weight by moving the cheese-plate a distance corresponding to the weight of slice desired.

CIRCULAR-FOLDING MACHINE.—G. A. Wenz and J. McKee, Jr., Bridgeburg, Ontario, Canada. In carrying out the present improvement the inventors provide a machine which will fold letters or circulars the requisite size to enable the same to be inserted in envelops, such folding or creasing operation being performed with positiveness, ease, and facility. The machine is so constructed that the unfolded circulars will at all times when in the receptacle be held in contact with feeding-rolls on top of machine, thereby insuring always an even regular feed of the letters or circulars when the machine is in operation.

MACHINE FOR PUNCHING OR SHEARING METAL.—R. Norrie, Dalla Dockyard, Rangoon, British Burmah, India. In this patent the invention relates to improvements in machines for cutting metal, and especially to those in which a cutting-blade is arranged to cut down between two lower stationary blades. It further relates to improvements in the construction of the upper cutting-blades and lower stationary cutting-blades to enable the machine to be used to shear out a strip of metal or punch out pieces, as desired.

SUPPORT FOR THROAT-PLATES OF SEWING-MACHINES.—F. L. Whitney, Lincoln, Neb. Throat or needle plates of sewing-machines are made quite thin to accommodate working parts located immediately beneath them. They are hence considerably elastic and correspondingly fail to afford firm or rigid support for the work being sewed, so that the needle encounters more friction in piercing the work. In case the needle is broken or bent in use it will strike the plate, which is liable to be broken, as well as the shuttle. This is likely to happen, especially in machines used for manufacturing purposes. Mr. Whitney has devised a support for the plate which renders it perfectly rigid, and avoids result above indicated.

PILE-WIRE MOTION FOR LOOMS.—R. Beattie, Littlefalls, and A. McKendrick, Paterson, N. J. This pile-wire motion is especially adapted for use in wide carpet-looms. The principal object is to do away with the large and cumbrous grooved wheel and the equivalents thereof which are now used on all looms of this character and at the same time to provide a less complicated motion as a substitute for the cam-motion now employed which will require less power and allow the loom to run at a greater speed and with fewer stoppages, thus increasing the production.

MIXING-MACHINE.—G. M. Andersson and A. G. Ahlstrom, Hydepark, Mass. The invention relates to machines employed for mixing liquids or plastic materials so as to render the mass homogeneous and thoroughly blend together the compound elements, and its object is to provide details of construction for a device, which adapt it for convenient use, render it perfect in operation, and enable the quick detachment of its several parts to facilitate thorough cleansing of the interior of the machine. One type is built for mixing cake, which needs hard beating, and it is claimed that it will do its work in one-tenth of the time required by hand.

CUTTING - MACHINE FOR PLASTIC MATERIALS.—E. Logan, Philadelphia, Pa. Mr. Logan's invention relates to machines for cutting disks or sections from a sheet of plastic material, and is particularly intended for cutting biscuit, cakes, or crackers from a sheet of dough. The object is to provide a machine which will cut a number of disks simultaneously and deposit them in a suitable receptacle in one operation. The machine has a minimum number of operating parts compact in structure and attachable to any table or other suitable support.

COTTON-PICKER.—W. W. Hoskins, Velasco, Texas. An object, among others, in this case is to provide a machine in which the picking devices start from their ground ends forwardly instead of rearwardly or vertically, whereby they come in contact with the top of the plant first and pick down, thus having an upward and backward pull on the plant in operation, and also to construct the picking devices of a picking-roller and an opposing feed-roller correspondingly inclined, and also the provision of other means.

INSTRUMENT FOR PLOTTING GEAR-TEETH.—C. F. Moon, Greensboro, N. C. The improvement relates to instruments for plotting gear-teeth, whether external or internal, and to marking off circles into subdivisions of uniform size. The instrument admits of general use, but is of peculiar value to architects, engineers, draftsmen, pattern-makers, and all other persons who may desire to divide circles or portions thereof into portions separated by radially-disposed lines.

APPARATUS FOR USE IN POLISHING CUT GLASS.—J. J. McCue, Jr., New York, N. Y. This apparatus is for use in polishing cut glass by means of dipping the article in acid. It has been found that polishing cut glass by mechanical methods is much less efficient than by means of an acid-bath. While the invention is especially designed for carrying out this process, it is not strictly limited thereto and is capable of other uses.

Pertaining to Vehicles.

GUIDE-LOOP FOR CHECKREINS.—E. Van Dyck, Adams, Mass. This improvement refers to guiding-supports for overdraw-checkreins. The object is to provide details of construction for a device which afford means to suitably support the rein from the crown-piece of harness and enable the introduction of the two members of an overdraw-checkrein within duplicate guide-loops without disconnecting said reins from the driving-bit or requiring them to be bisected and joined where cut with buckles to permit their loose insertion within the loops.

FOOT-PROPELLED VEHICLE. — W. J. SHIELDS, Bedford, Ala. The principal object of this inventor is to provide a vehicle which will enable occupants to propel it easily, while affording a far greater degree of comfort than usually attained in vehicles of this class. Further, one which may be easily controlled and adapted to be propelled by one or two persons, the seats being independently adjustable to facilitate simultaneous effort of two persons of different sizes in the propulsion of the vehicle.

TIRE-INFLATING PUMP.—S. E. SPENCER, Springville, N. Y. In this patent the invention has reference to improvements in pump mechanism for inflating the tires of motor-vehicles, an object being the provision of a pump mechanism that may be detachably connected to the driving-shaft of the motor and operated therefrom to quickly inflate the tires.

FELLY-JOINT.—J. B. HIGGINBOTHAM, Aberdeen, S. D. In this instance the invention relates to an improved device for connecting the sections of a wheel-felly so that the necessary tension may be exerted on said sections to draw them forcibly together and produce a rigid self-sustaining felly, which with the addition of the tire encircling it forms a most secure and durable structure.

SHIFTING-RAIL FASTENER FOR VEHICLE SEATS.—F. H. DELKER, Henderson, Ky. This invention consists in certain improvements upon the fastener for which Letters Patent of the United States were formerly granted to Mr. Delker. The present invention has for its principal object the provision of a simpler fastener than that disclosed in the former patent and one which may be more cheaply constructed. A further object is to provide a fastener which cannot be so easily accidentally disengaged and which will operate satisfactorily without an aperture in the spring-leaf member to weaken it.

Prime Movers and Their Accessories.

TURBINE.—C. N. SCHOTTMULLER, Taylor's Falls, Minn. In this patent the invention has reference to improvements in steam-turbines, and an object is the provision of a motor of this type that may be operated in either direction with an economical use of steam. Two or more turbines may be connected together, with condensers attached and operated as compound condensing-engines.

SHAFT LIQUID-SEAL PACKING.—C. L. COOK, Louisville, Ky. In this case the invention refers to improvements in packing for shafting, and particularly the shafting of turbine-motors and propeller shafts of steamships, an object being to provide a novel form of packing in which a liquid is employed as a packing or sealing medium, rendering the packing impervious to atmospheric pressure.

ROTARY ENGINE.—I. SEVERANCE, Minneapolis, Minn. The object of this inventor is to provide an engine arranged to allow convenient reversing to insure a positive working of the valves in unison with the rotary motion of the piston and to provide a continuous action of the motive agent under initial pressure on the piston-heads without the usual cut-off for each revolution of the piston.

Railways and Their Accessories.

TIE-PLATE.—B. S. WASSON, Chicago, Ill. In this patent the object is to provide a plate so constructed that when secured on a tie it will not buckle or work loose, also providing protection for the tie from cutting or wear from the rail-base and furnishing a means for rigidly securing the plate to a tie without danger of splitting the tie.

COAL, ORE, OR BALLAST CAR.—G. F. SIMONTON, Vanwert, Ohio. The invention relates to metallic freight-cars, the same being especially adapted for transportation of dumpable material—such as coal, ore, and ballast—although it may be employed for other classes of dumpable substances. In some features the present car is similar to the metallic cars disclosed by Mr. Simonton's prior applications for Letters Patent. One improvement of the present invention is a metallic underframing usable in connection with any style of car. Another, is the construction of the hopper-doors by which material may be discharged in the middle of the track, this being especially desirable when unloading ballast.

Designs.

DESIGN FOR A TOILET-POWDER RECEPTACLE.—S. M. COLGATE, Orange, N. J. The design of this ornamental receptacle for containing toilet-powder is very neat in appearance. It shows a receptacle very practical in shape for easy and convenient handling in use, and in fair proportion to its height the rounded article shows a width about double the thickness.

DESIGN FOR OIL CLOTH.—N. KLAU, New York, N. Y. The design of this ornamental oil-cloth is wholly pictorial, and comprises individual or cluster pictures of children in distinctly separated scenes of games, sports, and diversions of juvenile life of that kind enjoyed almost entirely out of doors.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of the paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

MUNN & CO.

Inquiry No. 6289.—For manufacturers of or dealers in Acido Anhidrico Sulfuroso Vinario.

Inquiry No. 6290.—For manufacturers of lens-grinding tools.

Inquiry No. 6291.—For makers of gates for buggies or wagons which may be opened without having to get out.

Inquiry No. 6292.—For makers of small gas, gasoline and steam engines and parts for amateur use, ¼ to ½ h. p.; also of castings or draft forgings in mild steel for dynamos.

Inquiry No. 6293.—For machinery for grinding alfalfa meal.

Inquiry No. 6294.—For makers of hand fire engines, or "hand tubs," operated by several men at pumps, with hose laid into wells or river.

Inquiry No. 6295.—For manufacturers of small tin caps, such as used on tops of beer bottles.

Inquiry No. 6296.—For manufacturers of thread and small spools.

Inquiry No. 6297.—For makers of small paste-board boxes for mailing purposes.

Inquiry No. 6298.—For turbine water wheels for a small mill.

Inquiry No. 6299.—For manufacturers of labels.

Inquiry No. 6300.—For manufacturers of and dealers in automobile parts.

Inquiry No. 6301.—For manufacturers of sewing needles.

Inquiry No. 6302.—For manufacturers of castings for gas engine cylinders.

Inquiry No. 6303.—For manufacturers of corrugated rollers, such as used for corrugating wrapping paper boards.

Inquiry No. 6304.—For makers of rice-milling machinery.

Inquiry No. 6305.—For makers of bottles for soda water, on the same style as the English-made "Codd's ball-stoppered bottles."

Inquiry No. 6306.—For Foster's gluten tester, and for a tintometer to be used in testing wheat and flour.

Inquiry No. 6307.—For manufacturers of razor handles, also for dealers in English steel.

Inquiry No. 6308.—For manufacturers of decorative glass spangles.

Inquiry No. 6309.—For manufacturers of or dealers in voting machines similar to those used in New York State.

Inquiry No. 6310.—For machines for making gas from gasoline.

Inquiry No. 6311.—For a mill for powdering licorice root or any similar hard root.

Inquiry No. 6312.—For toy steam engines and steam locomotives for experimental purposes, not to be over ⅛ h. p.

Inquiry No. 6313.—For makers of twisted metal concrete and expanded metal for fireproofing and concrete construction.

Inquiry No. 6314.—For a metal out of which to make a pump for pumping a weak solution of chlorine in water, without injuring the pump.

Inquiry No. 6315.—For makers of rug machinery for manufacturing old carpets into rugs; also for broom-making machinery.

Inquiry No. 6316.—For a glass disk 10 or 12 inches in diameter from which to grind a mirror for a reflecting telescope.

Inquiry No. 6317.—For the address of the manufacturers of the "Eclipse" smoothing iron.

Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.

Scientific American Supplements referred to may be had at the office. Price 10 cents each.

Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled.

(9493) E. L. S. asks: 1. How can you tell from the appearance of copper wire when it is burned out? A. You can tell from the appearance of copper wire that it has burned out. If it has burned out it will not be there, any more than a stick of wood or a coal will still be in existence after it has burned out. A "burn-out" is a melting and burning of the wire because of heat. 2. What is meant by the sidereal system? A. The sidereal system is the portion of celestial space occupied by the stars, in distinction to the space occupied by the sun and the planets, the solar system. 3. Can you give me some of the theories why the planet Mars is red? A. The planet Mars is red because its surface is composed of red materials, or because its atmosphere absorbs the other light waves. 4. Why does green wall paper contain arsenic? A. Green wall paper contains arsenic when arsenic is used as a color to print the paper. Paris green is a very beautiful green, and hence was frequently used for printing wall papers. If Paris green is not used, there will not be arsenic in the color. 5. What causes spontaneous combustion? A. A rapid absorption of oxygen, sufficiently rapid to injure the material, is spontaneous combustion. It occurs with paint oils, principally when cotton rags or waste are saturated with a drying oil. 6. Will you please tell me the names of the lightest and heaviest metals known, and their weights? A. Potassium is the lightest metal, with a density of 0.86 to 0.88, and iridium is the heaviest metal, with a density of 21.78 to 22.42. 7. Please explain the working of a steam turbine? A. A steam turbine is driven by jets of steam striking directly against the blades of the rotating parts.

(9494) W. O. S. writes: I am tempted to use your valuable paper, to find out if it is possible to mold articles out of cement, and what substance or composition would have to be used to get as clean a cast as articles molded out of plaster of Paris. A. It is possible and practical to mold hydraulic cement in the same manner as plaster of Paris. The cement should be finely ground and quickly mixed with water, and thick, so as not to run freely, pressed into an oiled mold the same as with plaster. It requires longer time to set than plaster.

(9495) A. K. S. writes: In the picture of a Panhard going 80 miles an hour, printed on front page of your issue of October 22, I noticed the wheels appear very elliptical and the housing is diamond-shaped. Will you be kind enough to explain how this peculiarity occurred? Was it due to the fact that the whole surface of the plate or film was not exposed simultaneously by the action of the shutter, thus allowing some parts enough time to blur, while others did not have time? A. The drawing out of the image of a wheel in a snap-shot picture is due to the fact that the car moved while the picture was being taken. A velocity of 80 miles an hour is 117 feet a second. If the exposure were only a hundredth of a second, the car moved a foot while the shutter acted. The lengths of snapshots are very uncertain quantities, and often they are longer than the figures on the shutter would indicate. A slight friction in the plates will make the exposure longer.

(9496) H. H. says: 1. Please inform me of a simple and reliable method of measuring the internal resistance of primary batteries. A. The simplest method of measuring the internal resistance of battery cells is to connect two cells or any number of pairs of cells in opposition, and measure their resistance by a Wheatstone bridge, in the same manner as any other resistance is measured. The cells in opposition send no current into the apparatus, and thus are like any other resistance in opposing the current of the battery of the measuring set. 2. Also the formula for the mixing of paste for positive and negative plates for storage battery. A. The paste for coating the positive plates of a storage cell is made by mixing red lead to the consistency of putty with dilute sulphuric acid made by slowly pouring one part of concentrated sulphuric acid into four times its volume of water. Be sure to pour the acid into the water slowly and with constant stirring. The paste for the negative plate is prepared in the same way with litharge.

(9497) O. R. writes: I desire to obtain or purchase a formula to make the best up-to-date instrument for locating gold and silver. Can you sell me formula for the same so constructed that it can be set to attract one metal and cut off all other attractions? A. We know of no formula or instrument for locating the precious metals but the prospector's judgment, founded upon experience and the diamond core drill. All so-called devices for locating gold and silver are inoperative. There is a device described in our issue of May 2, 1903, which will locate an electrical conductor in the ground, but there is no means of determining without the use of pick and shovel whether this conductor is a valuable mineral deposit or a stratum of moist earth.

(9498) E. E. P. says: I am trying to find out what will be the most satisfactory power for grinding corn and pumping water for irrigation—gasoline engine, kerosene engine, electricity by windmill, liquid air, or just the old-fashioned windmill. A. The cheapest power for a farm for all purposes is a windmill of modern type large enough for the requirements of the farm work. A 30-foot windmill will give 3 horse-power in a 16-mile-per-hour wind, and will do much of the work even for a small threshing machine. Where large quantities of water for irrigation and the heavier machinery are in use, a kerosene engine is a very cheap power ever ready and easily managed.

(9499) V. K. asks: What is the cause of the pitting of steam boilers? Does such pitting occur where soft water is used, rain or condensed water or soft spring water? Do you know of any remedy preventing such pitting? I have a steam boiler that is pitted in several places below the water line, pits nearly as large as a dollar, varying in depth to nearly an eighth of an inch deep in places. I am at a loss to find a remedy. I use hard water containing considerable lime and magnesia, and to prevent or retard formation of scale I daily inject a solution of sodium phosphate. A. The pitting of boiler tubes and shell is a common occurrence due to any kind of water, but more active with the purer or rain water. The cause has been attributed to some peculiar molecular condition of the iron inducing electrical action, and also to particles of slag or other metals that induce electrolysis.

(9500) H. E. F. says: 1. A claims that the ocean has deep pits that have never been sounded, the reason being that no solid body could reach the bottom. B claims that the water of the ocean is, no doubt, under a tremendous pressure, but still could not exceed the specific gravity of some of the heavy metals—granting the depth exceeds 60,000 feet. A. We have answered this question five times in recent years, in this column, but will try again. Water is a very incompressible substance. Sea water is compressed but forty-four millionths by a pressure of an atmosphere, and at higher pressures the compression is less than this. It is not very sensibly denser at the depth of the bottom of the ocean than at its surface, nor are the metals. A body which will sink at the surface of the ocean, will continue to sink to its bottom. This is known, since the sounding lines bring up from all bottoms the fine ooze, which consists of minute forms of life which have died and sunk till they rested on the ocean bottom. There have not been any depths found which the sounding line has not measured and brought back testimony that it touched the bottom. The greatest depth yet found is 30,930 feet, in the South Pacific near the Fiji Islands. Another depth near Japan is 27,600 feet, and one near Porto Rico is 27,366 feet. The deepest places are near the shores. For other information on this interesting point, see Query 8959, volume 88, No. 17. 2. What is the increased pressure for volumes injected into a closed vessel filled with water? A. The increase of pressure produced by forcing a plunger into a closed vessel filled with water may be anything which the walls of the vessel can stand. This pressure may be increased till the strongest vessel is burst by the water pressure. This is known in books upon physics as hydraulic pressure, and the machine for utilizing it is called the Bramah or hydraulic press. Pascal stated its law many years ago: "Pressure exerted upon an inclosed mass of liquid is transmitted undiminished in all directions, and acts with equal force on equal surfaces and in a direction at right angles to those surfaces." This press is the most powerful machine man has ever invented. It has no limit except the strength of the material upon which it presses. It is in use for all great press work. Owing to the slight compressibility of water as given above, you cannot inject any considerable volume of anything into a closed vessel filled with water. It will burst the vessel.

(9501) C. D. C. asks: Would you kindly explain the following: A three-speed desk fan and a 16-candle-power light are connected across one side of a three-wire direct-current. The fan is connected about 20 feet from the light, between it and the source of supply, and is turned off. A wireman, thinking the circuit disconnected at the service switch, cuts the lamp cord with his pliers, when the short circuit is formed, the fan starts and runs until the short circuit is broken. What caused the fan to run? A. In the case you describe, when the short circuit was established by cutting the lamp cord, the rush of current into the line was so great that it set the motor in motion. This was not a short circuit, since the resistance of the motor was sufficient to prevent that, but it was enough to run the motor. We have seen lamps burned out on a line in the same circumstances, lamps which were not turned on at all by a burn-out on the same line near them.

(9502) G. F. G. asks: Can you make clear to me the difference of the terms "force" and "energy"? I am studying physics, and find difficulty in understanding just what is force and what energy. Anything you can furnish me with will be appreciated. A. Force is that which produces, changes, or destroys motion. Energy is the power to do work. Put forth your energy, and you can exert force in working upon bodies. Energy is not force; it is that in you which makes you feel that you can do something. Energy in a moving body enables it to do work upon some other body. Energy in a weight which has been raised to a height enables it to do work by falling from that height. Steam in a boiler has energy or ability to do work, but it is not doing any work so long as it is shut up in the boiler. Let it out into the cylinder, and it will exert force in pushing the piston to and fro, and thus do work in moving the train. Force does work. The energy or ability to do work can be measured in terms of the work which might be done if the energy were turned into work. The three words energy, force, work, stand in a logical series, and each has its place. Energy is not force except by an incorrect use of words, and force is not work.

(9503) M. M. asks: 1. Are dry batteries after having run down and been recharged from dynamo as good as originally? A. A dry cell cannot be made as good as at first by recharging. The so-called recharging consists in sending the zinc back to the positive end of the cell, and thus rendering it possible to use the cell as a source of current again. It will perhaps give about one-half as much as at first. If the electricity for recharging costs anything, it is probably not worth the doing. 2. Can "1900" type dry batteries be recharged from direct-current generator giving 3 amperes at 10 volts? A. Any dry cell can be recharged. Only a direct-current can be employed for charging storage cells or recharging dry cells. 3. How many, and how should they be connected? A. Five or six may be connected in series and connected to the dynamo. Connect the positive pole of the dynamo to the carbon, and the negative pole to the zinc of the series to be charged. 4. If it is possible to connect six in series, how long would it take to charge them? A. We cannot tell how long to continue the charge, except to say use a voltmeter and charge till further charging produces no further increase of voltage in the cells.

(9504) H. P. S. asks: Will you please give an explanation of the phenomenon which I noticed lately? I was developing films from a film pack, and each time I had to tear off a black paper, which was attached to the film by means of a silk adhesive strip; each time I noticed a glow, which followed up the parting of the paper and adhesive strip between the two. My explanation for it was that there was electricity formed by the parting of the molecules of the two parts. Was I right? A. The light which you observed in pulling a silk strip from a dry paper was due to the charge of electricity produced by friction. There are many cases of this in cold weather, especially. Stroking a cat in the dark, one may see the flashing of light from her dry fur. It does not appear to be necessary to consider it due to molecular action.

(9505) T. A. asks: 1. Can you please let me know, through your "Notes and Queries" column, how to make a choke coil such as is used for wireless telegraphy? A. A choke coil is usually wound with a wire core, but may have a great variety of windings according to the idea of its designer. Some have omitted the wire core. You will find a variety of designs in Mayer's "Wireless Telegraphy," which we send for $2, mailed. 2. Will you also explain how it stops the waves from going through the relay and battery instead of the coherer? A. The action of a choke coil is a self-inductive one. The rapidly alternating surgings of electric waves is greatly impeded by the induction of the turns of the choke coil upon each other. Alternating currents are frequently controlled by choke coils, just as direct currents are cut down by rheostats.

(9506) C. H. S. asks: 1. What is the extent and knowledge of the Sargasso Sea, and is it true that part of the ocean equal to one-half of Europe is entirely unexplored? A. The Sargasso Sea is an area destitute of currents, a quiet place in which there are many varieties of sea weeds and lower forms of animal life. It extends from 25 deg. to 35 deg. N. latitude, and from 20 deg. to 30 deg. W. longitude. It owes its character to the fact that the water is not in motion. It is not probable that any extent of ocean except in the frigid regions has not often been crossed by ships. Atlases do not show any such unexplored region of ocean as you describe. 2. Do astronomers still hold that Venus revolves only once in a year? A. It is probable that Venus rotates on its axis once in a revolution around the sun, or once in one of its years.

(9507) F. S. P. asks: Will you kindly inform me, through your answer to inquiry department, what is the theory of the firefly's light? Or in other words, what use to the bug is its light? A. The theory advanced as to the purpose of the firefly in displaying its light is that it is a sexual call, just as is the mating song of birds. We have never met any other, and this seems sufficient.

(9508) S. E. O. asks: Will you kindly let me know what kind of chemical it is that changes color with the change of weather? I have a small piece of goods about two inches square, that in clear weather is a blue; when a change is near it turns to violet, and for rain it turns to bright pink. If you can tell me the name of the chemical you will oblige me very much. A. The cloth which changes color with a change of weather is dyed with chloride of cobalt. The change is due to moisture. You can produce it by breathing upon the cloth; it does not indicate a change of pressure of the atmosphere as a barometer does, and hence is usually behind the change of weather. The barometer indicates the cause of the storm; the color indicator shows the effect of the storm.

NEW BOOKS, ETC.

Hints on Revolver Shooting. By Walter Winans. New York and London: The Knickerbocker Press, 1904. 16mo.; pp. 130. Price, $1.

A revolver in itself is a very useful weapon of defense; but unfortunately, many people are not able to use it properly. It is the object of the present little book to give such instructions as will enable anyone to select, sight, and fire a revolver. The book deals with the competitions at Bisley, England, stage shooting, trick shooting, etc.

The Polishing and Plating of Metals. A Manual for the Electroplater, Giving Modern Methods of Polishing, Plating, Buffing, Oxidizing, and Lacquering Metals, for the Progressive Workman. By Herbert J. Hawkins. Chicago: Hazlitt & Walker, 1904. 12mo.; pp. 355. Price, $2.

There is considerable call for a new work on plating, to deal with the conditions as we now find them. It is a thoroughly practical work, giving valuable rules and formulæ. It is a book which should be welcomed by all electroplaters.

Electrical Engineering for Students. By S. R. Bottone. London: Guilbert Pitman, 1904. 16mo.; pp. 153. Price, 80 cents.

The works of Mr. Bottone have been numerous, and have proved very helpful to the amateur. The present volume will prove no exception to the rule. It is divided into two parts, the first dealing with magnetism and magnetic apparatus, while the second part treats of static electrical instruments. The book will be of particular value to those who are desirous of obtaining practical knowledge of electrical work, and find themselves hampered by their inability to see or to make the instruments of which they read in textbooks.

Letters on the Diseases of Plants. By N. A. Cobb. Sydney, Australia: The Government of the State of New South Wales, 1904. Pp. 133.

This book is reprinted from the Agricultural Gazette of New South Wales, with additions and emendations. There are over 150 original illustrations and 7 original colored plates, together with 4 plates copied from various authors. It is a very creditable production.

The Purification of Sewage. Being a Brief Account of the Scientific Principles of Sewage Purification and Their Practical Application. By Sidney Barwise, M.D. (Lond.), B.Sc., M.R.C.S., D.P.H. (Camb.) With numerous illustrations and diagrams. New York: D. Van Nostrand Company; London: Crosby Lockwood & Son, 1904. 8vo.; pp. 240. Price, $3.50.

The progress which has been made during the last few years, more particularly in the mechanical arrangements for making percolating filters automatic and in the distribution of sewage, has necessitated the rewriting of the present work so as to bring it up to date. This work is written by an English medical health officer, and it shows painstaking care in its preparation. It will be useful to all sanitary engineers and bacteriologists.

Analyse des Matières Alimentaires et Recherche de Leurs Falsifications. By Ch. Girard, Director of the Municipal Laboratory of Paris, in collaboration with MM. Sanglé-Ferrière and De Brévans, Sub-Chiefs of the Municipal Laboratory, and MM. Truchon, V. Genin, Pons, De Raczkowski, Leys, Froideveaux, Cuniasse and Lafaye, Chemists of the Municipal Laboratory. Paris: Vve. Ch. Dunod, 1904. 8vo.; pp. 872, with illustrations. Price, $7.50.

The present, or second, edition of this volume contains some 200 pages more than the first edition; and besides the original articles by MM. Bordas, Saglier, Ladan-Bockairy, Robin, and P. Girard, which were published in the former edition, there is much supplementary material, in which the latest methods of analysis and research have been described with the greatest care, thus bringing to the knowledge of chemists and pharmacists the latest scientific novelties concerning the analysis of food products. Several additional articles, such as those on water, milk, preserves, etc., contain new and interesting facts; while others on saccharimetry, the analysis of sugars and of sugary substances, are entirely new. Because of their clear presentation, the methods here described permit the chemist, with the aid of tables and numerous examples, to comprehend with the greatest facility the slightly complex calculations which belong to these delicate researches. The book treats successively of potable waters, wine, beer, cider, vinegar, alcohols and spirits, milk, butter, cheese, oils, meats, cereals, farinaceous products, bread, cakes and cake making, coffee, chicory, tea, cocoa, chocolate, sugars, preserves, food products, spices and aromatics, colors employed in food materials, etc. Independently of chemical analysis proper, the bacteriological and bibliographic parts of the work have been largely added to, and their connection with the former articles constitutes a work indispensable to all persons interested in the hygiene of foods.

Self-Propelled Vehicles. A Practical Treatise on the Theory, Construction, Operation, Care, and Management of All Forms of Automobiles. By James E. Homans, A.M. New York: Theodore Audel & Co., 1904. 8vo.; pp. 672. Price, $2.

An excellent book, dealing with the practical side of the construction and operation of automobiles. We do not know of any more useful book for those who wish to understand the mechanism of various types of automobiles. The present is a revised edition, and it contains complete illustrated descriptions of the latest American automobiles and auto novelties.

An Introduction to the Modern Theory of Equations. By Florian Cajori, Ph. D. New York: The Macmillan Company, 1904. 12mo.; pp. 239. Price, $1.75.

Most textbooks, particularly on mathematical subjects, can hardly be called books of instruction, as they seem to take it for granted that the student is thoroughly familiar with the subject, instead of taking the position that the student is ignorant of the subject and all details thereof must be explained to him. Dr. Cajori is known as a man who writes clearly and interestingly on subjects of difficult nature. His present work is no exception to this rule; the arrangement is new, and while the subject-matter is of course old, his handling of it is quite different from the usual. Particular attention is paid to exercises, making the subject more concrete. The Galois theory of equations, which is usually found by the beginner quite difficult of comprehension, is specially dealt with.

L'Ozone et ses Applications Industrielles. By H. de la Coux, Engineer, Chemist, and Inspector of Technical Instruction for the Minister of Commerce. Paris: Vve. Ch. Dunod, 1904. 8vo.; pp. 557; 159 figures. Price, $4.50.

In this new work M. de la Coux, after having described ozone in its physiological and therapeutic rôle, studies its methods of preparation, and treats of the considerations which influence its economic preparation. The new industrial ozone generators are also described. There are some remarkable properties shown by this gas from the chemical point of view. Certain of these are utilized in the preparation of particular products, which the author acquaints us with. Ozone acts energetically on microbes, and the sterilization of water, air, and various other substances is obtained with it. Each of these subjects has been the object of a special article, showing the complete processes and installations involved. The application of ozone to the treatment of brandies, spirits, and wines, to the manufacture of vinegar and cider, and to distillation, is also thoroughly described. Its use for the whitening of textile fibers, tissues, paper, straw, wax, feathers, etc., is described at length, as well as its use in starch making and in the manufacture of dextrines. After having gone thoroughly over the subject of the use of ozone in the manufacture of oils, greases, soap, varnish, lacquer, etc., its use is also described in the preparation of perfumes and coloring materials, and in dyeing. Among other uses to which ozone is being put are its employment in silkworm culture, in the aging of woods, in bleaching, the disinfection and sterilization of linen and tissues, and in photography. Finally, the analysis of ozone, which is so useful in the control of these various operations, has been very completely described from the qualitative and quantitative point of view.

The Study of American Coals. By William Jasper Nicolls, M.Am.Soc.C.E. Philadelphia and London: J. B. Lippincott Company, 1904. 8vo.; pp. 396. Price, $2.

Primarily this work is designed for those who wish to be informed on the subject of coal without searching through scattered publications. The writer has gathered the material from every available source, and has added it to his practical knowledge gained by experience in the coal fields of Pennsylvania. The book is an interesting one, and deals with the origin, development, transportation, and consumption of coal. The whole range of the subject is dealt with, from the theories of the origin of coal and the geology to the by-products. It is very interesting, and its usefulness is not confined to operators, miners, dealers, and carriers; but to the multitude of consumers—the American people.

Notes on the Composition of Scientific Papers. By T. Clifford Allbutt, M.A. London: Macmillan & Co., Ltd.; New York: The Macmillan Company, 1904. 12mo.; pp. 154. Price, $1.

While this is primarily intended as an aid to students in writing scientific theses, many of our popular writers of fiction and of fact might profitably consider the principles and the methods here laid down. It is a really excellent little "preachment," as Fra Elbertus would say.

Optical Tables and Data. For the Use of Opticians. By Silvanus P. Thompson, D.Sc., F.R.S. London: E. & F. N. Spon, Ltd.; New York: Spon & Chamberlain, 1900. Price, $2.50.

As its title indicates, a compilation of tables and information for opticians and others, in notebook form.

The Academic Review of Arithmetic With Questions and Problems. By Guy E. Transue. Clarksville, Mich.: G. E. Transue, 1902. 12mo.; pp. 281.

This book has been written for review purposes only, and it contains the pith of all the best arithmetical works which have come to the author's notice. The first part of the book is devoted to the science of the subject and analysis of processes, and the second part to mechanics and business. A new method of finding the exact divisors of any given numbers will be found most useful. Simple mechanical drawing, with practical measurements and considerable data of value to those interested in the mechanical trades, will also be found in its pages, as well as a considerable amount of information on the making of notes, figuring of interest, etc.

Carburation et Combustion dans les Moteurs a Alcool. By E. Sorel. Paris: Vve. Ch. Dunod, 1904. 8vo.; pp. 280. Price, $2.50.

Much has been said, *pro* and *con*, regarding the employment of alcohol in explosive motors. Its adherents declare that it can be substituted for gasoline in any motor, and that it does not leave any disagreeable odor or produce any smoke. Its detractors claim that it produces acids which attack the cylinders and valves, causing the latter to stick to their seats after the motor has cooled off. These praises and reproaches are not well founded. All depends on the circumstances under which it is used, and the method of producing the mixture of air and the combustible. M. E. Sorel, in this new work, indicates the conditions under which alcohol can be successfully used. He compares alcohol with the other hydrocarbons, and then studies various parts of the motors, especially the carbureters, which influence its use. Finally he makes known the laws which govern the phenomena of combustion, and which are generally not well understood by the constructors of this type of motor. The book has complete tables of the various fuels used in automobile motors, and of their conditions at different temperatures. The temperature of vaporization of these fuels is gone into very thoroughly. Many other points that bear on the subject are discussed. The book will be found most valuable to constructors of explosive motors of all types.

Elements of Mechanical Drawing, Their Application, and a Course in Mechanical Drawing for Engineering Students. By Alfred Pierce Jamison, M.E. New York: John Wiley & Sons, 1904. 8vo.; pp. 226. Price, $2.50.

This textbook is intended to give the student such knowledge as will prepare him for a course in engineering, besides aiding him in obtaining sufficient practice in drawing to qualify him to do ordinary commercial drafting. The text is amply illustrated with samples of lettering, sample plates, descriptions of instruments, and the like. It is written largely in the form of problems and their solutions and there are also chapters on mechanical execution of drawings, sketching, color work, and the reproduction of drawings. The chapter on projection goes into the subject thoroughly, yet concisely. The book, as a whole, is a complete handbook for draftsmen.

Etude Théorique des Alliages Métalliques. By Leon Guillet. Paris: Vve. Ch. Dunod, 1904. 8vo.; pp. 232; 117 illustrations. Price, $2.75.

Alloys have, from an industrial point of view, a considerable importance; it is, in fact, rarely that metals are employed in their pure state. Recent researches on alloys have shown that physical, chemical, and mechanical properties of these products depend essentially on the state of the different metals that enter into the compound. It is, therefore, of great interest to determine exactly this state. The aim of the present work is to study the different methods which will lead to this knowledge, to show all the conclusions that have already been drawn from such knowledge, and to describe the different alloys utilized in the industries. The

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work is essentially theoretical in character, the author having recalled the law of phases on which the theory of alloys is based. In the following chapters he has studied the curves of fusibility and of cooling, microscopic metallography, etc.; in fact, all the methods which conduce to clearing up the constitution of metallurgical products. Each chapter contains three divisions, which give: (1) the principle; (2) the methods; and (3) the examples. The examples have been drawn in every instance from important works treating of siderurgical products, and to which are attached particularly the names of MM. Le Chatelier, Osmond, and Hadfield.

History of Composing Machines. By John S. Thompson. Chicago: The Inland Printer Company, 1904. 12mo.; pp. 200; fully illustrated. Price, $3.

This book gives a good description of almost every typesetting machine of any importance which has come into practical use. Over sixty different machines and processes for setting type mechanically are illustrated and described, and the entire art of mechanical typesetting is reviewed in detail. The book will be found most valuable by all printers and others who have to do with printing, as a historical and reference work. It is completed by an accurate list of all patents, both British and American, which in any way relate to the subject. The book is extremely well illustrated with some fifty half-tone plates.

Stories of Inventors. By Russell Doubleday. New York: Doubleday, Page & Co., 1904. 8vo.; pp. 221; 33 illustrations. Price, $1.25.

This book tells in a graphic way the interesting adventures of inventors and engineers, many of which adventures are incidents and personal experiences. Most well-known modern inventions, which are now in, or are rapidly coming into common use, are illustrated and described. Marconi and wireless telegraphy; Santos-Dumont and his flying machines; fast trains and their operation; automobiles and their various uses; steamboats, submarines, and life-saving apparatus are among the subjects touched upon. Other interesting stories are told of bridge builders and some of their achievements, while artificial ice-making, long-distance telephony, and moving pictures and typesetting machines each come in for a good share of descriptive matter. The book is well illustrated with fine half-tone plates reproduced from the Scientific American and the Booklovers' and Holiday magazines. It will be found most interesting reading by all who wish to learn the romance of invention.

Experiments With Alternate Currents of High Potential and High Frequency. By Nikola Tesla. New York: McGraw Publishing Company, 1904. 12mo.; pp. 162. Price, $1.

This book consists of a lecture delivered before the Institution of Electrical Engineers at London, in which are described some interesting experiments of the author on high potential and high frequency currents. An appendix contains an article on the transmission of electrical energy without wires, which was written as the result of experiments by Tesla with this end in view. The Appendix is illustrated with photographs of the author's experimental laboratory in Colorado and transmitting tower on Long Island for wireless telegraphy.

La Pratica della Fonderia. By Aurelio Aureli. Milan: Ulrico Hoepli, 1904. 8vo.; pp. 756; 528 illustrations. Price, $5.

This volume forms a very complete treatise of Italian foundry practice as exemplified by some of the best Italian founders. The author has had a large experience in foundry work in the Grande Fonderia della Societa degli Alti Forni, and in other Italian foundries, and the results of this experience he has set forth very clearly in the present volume. The work is divided into fifteen chapters. The opening chapters treat of different kinds of steel and the various tests of steel, both mechanical and chemical. The different methods used in casting, refining, and treating steel are gone into at great length, and considerable attention is given to the manufacture of models from which to make castings. The work is very thoroughly illustrated by diagrams, and it also contains tables giving the composition of different steels. It will be found most useful by all persons who have to do with the steel industry.

Scaffolding. A Treatise on the Design and Erection of Scaffolds, Gantries, and Stagings. By A. G. H. Thatcher, Building Surveyor. London: E. P. Batsford, 1904. New York: D. Van Nostrand Company. 8vo.; pp. 185; 152 illustrations. Price, $2.

The practice of allowing workmen to erect scaffolds without the aid of expert supervision is strongly to be deprecated. The architect, builder, or clerk of works should always be held responsible for their erection. The risk of defective or unsafe work would thereby be minimized, and there would be found an economy of both labor and material. The author has endeavored in this work to give practical details of construction, and yet the theory of construction has also been treated in terms well understood in the building trade. The book treats of various kinds of scaffolds, scaffolds for special purposes, shoring and underpinning, timber, cordage and knots, the transport of material, the stability and strength of scaffolds, and scaffold accessories and their use. The prevention of accidents and the laws affecting scaffolding are also discussed. Besides numerous diagrams, the book contains six full-page plates reproduced from photographs of actual constructions.

Trattato di Chimica Inorganica Generale e Applicata all' Industria. By Dott. E. Molinari. Milan: Ulrico Hoepli, 1904. 8vo.; pp. 693; 178 illustrations. Price, $5.

This book treats of the preparation and manufacture of different chemicals. All the latest processes are described in detail in the second part of the work, while the first part is theoretical in character, and describes numerous laboratory experiments in connection with the preparation of various substances and gases. Like most of the volumes published by the Hoepli establishment, this one is exceedingly thorough and complete in dealing with the subject in hand. It will be found of great use to all inorganic chemists who are engaged in industrial work.

Alternating Current Engineering. By E. B. Raymond. New York: D. Van Nostrand Company, 1904. 12mo.; pp. 232; 102 illustrations. Price, $2.50.

Most of the treatises on alternating current engineering require a knowledge of calculus on the part of the reader, and the few works which avoid the use of calculus are only too apt to be filled with difficult algebraic problems. To the large number of young men who enter electrical lines of work without a technical education, such books are valueless. Mr. Raymond in his present work has realized the importance of avoiding all complex explanations, and the book is written in a very simple and clear style. The first part of the book explains the general laws of magnetism as applied to alternating work, and the second part deals with alternating apparatus describing the principles of design and operation, and giving the best methods of test.

The Waterproofing of Fabrics. By Dr. S. Mieckinski. Translated from the German by Arthur Morris and Herbert Robson, B.Sc. New York: D. Van Nostrand Company; London: Scott, Greenwood & Co., 1903. 16mo.; pp. 104. Price, $2.50.

There is hardly a single phase of technology that does not have its literature. There has been a great demand for literature on waterproofing, but the supply is meager, so that any contribution to the subject will be warmly welcomed. The author has performed his task in such a manner that the product will be useful to those who are interested in the manufacture of impermeable fabrics. The list of waterproof paints is an excellent one, and formulas are given.

Special Method in Elementary Science for the Common School. By Charles A. McMurray, Ph.D. New York: The Macmillan Company, 1904. 8vo.; pp. 275. Price, 75 cents.

This book should be read by all teachers of natural science, as it contains many very good ideas, which will be found most helpful as an aid in the instruction of classes. The book goes into the history and aim of science teaching, and helps the teacher plan a course of study and simplify it as much as possible. The basis for selecting and arranging topics for the course of study is thoroughly discussed, as well as the gradual approaches to science, and the application of science to life. Method in science lessons is insisted upon, and the teacher is aided in obtaining this by means of several illustrative lessons and a complete outline of a course of study. The work is completed by a list of books which have been found valuable in science teaching.

Les Richesses Minerales de la Nouvelle-Calédonie. By M. E. Glasser, Ingenieur au Corps des Mines. Paris: Vve. Ch. Dunod, 1904. 8vo.; pp. 560; 6 plates. Price, $3.

M. E. Glasser, who was sent by the Minister of Colonies to study the mineral resources of New Caledonia, has given a very complete account of the same in his present report. After having discussed the general geological formations that are to be found in different parts of New Caledonia, the author makes known, for each class of mineral products, what are the sources of supply, the amount of development that has been done, and the industrial conditions under which the mines are exploited, as well as the development to which they appear capable of attaining. Nickel, cobalt, chrome, iron, copper, gold, coal, etc., are thus successfully reviewed. The author ends his volume, which is completed by a number of plates showing the mineral deposits, by considerations regarding the future of these mines and the measures to be taken in securing their values.

Subject List of Works on Electricity, Magnetism, and Electro-Technics in the Library of the English Patent Office. London: The Patent Office, 1904. Price, 25 cents.

This list consists of two parts, as follows: a general alphabet of subject headings, with entries in chronological order of the works arranged under these headings; and a key or a summary of these headings shown in class order. The headings have to deal with the contents of the works catalogued, and do not give necessarily the title pages, which are often misleading. The entries under the headings are arranged in chronological order, which will be found of considerable assistance to the investigation of matters of historical interest. The list comprises some 2,374 works, representing 3,792 volumes. The entries in the catalogues relating to these works are 2,948, and are distributed under 307 headings and subheadings.

Hoisting Machinery. Including the Elements of Crane Construction and Descriptions of the Various Types of Cranes in Use. By Joseph Horner. Philadelphia: J. B. Lippincott Company, 1903. 12mo.; pp. 252; 215 engravings. Price, $3 net.

This treatise is in four sections. Section 1 deals with the elements of crane construction; section 2, with the methods of operation; section 3, with the materials used in cranes, and their specific application; and section 4 with the various types of cranes, both hand and power. A full consideration of all the types now in use would require several large volumes; to present in concise form the leading features of those most in use has been the aim of the writer. By thus keeping the work within moderate limits, its value as a practical handbook has been enhanced, and reference facilitated.

Twenty-Sixth Annual Report of the State Board of Health of the State of Connecticut. For the Year 1903. New Haven, Conn.: The Tuttle, Morehouse & Taylor Company, 1904.

While this public document should be of particular interest to the people of the Nutmeg State, its statistics and records are capable of a much wider and more general application. Subjects such as "The Death Rate Not a Criterion of Public Hygiene," "Water Filtration," and "The Influence of Vaccination on Human Life," should claim the attention of every member of a civilized community. The Report includes the registration records for 1902 relating to births, marriages, deaths, and divorces.

Radio-Activity. An Elementary Treatise from the Standpoint of the Disintegration Theory. By Frederick Soddy, M.A. New York: The D. Van Nostrand Company; England: The Electrician Printing and Publishing Company, Ltd., 1904. 8vo.; pp. 214; 40 illustrations. Price, $3.

In the present volume the author has attempted to give a connected account of the remarkable series of investigations which have followed M. Becquerel's discovery in 1896 of the new property of the element uranium. The discovery of this new property of self-radiance, or "radio-activity," has proved to be the beginning of a new science, in the development of which physics and chemistry are worked together in harmony. In these advances physics and chemistry have borne an equal share; and in the close communion of the two sciences throughout the investigations, the secret of rapidity and definiteness of progress is to be found. Radio-activity has passed from a position of a descriptive to that of an independent philosophical science, based upon principles, only the germ of which is to be found in physics and chemistry as they were understood before its coming. The author has gathered up scattered threads, and has woven them into a book which will be of great interest to the physicist and to the chemist. It is a thoroughly satisfactory treatise on a new phase of science, the literature of which is still in its infancy.

American Small Arms. A Veritable Encyclopedia of Knowledge for Sportsmen and Military Men. By Edward S. Farrow. New York: The Bradford Company, 1904. Quarto; 500 engravings. Pp. 408. Price, $5.

The author of this book is a well-known writer on military matters, and is a late assistant instructor of tactics at the United States Military Academy. The book is well gotten up, is very comprehensive, and is quite the best book we have seen on the subject.

Textbook of General Physics for High Schools and Colleges. By Joseph S. Ames, Ph.D. New York: American Book Company, 1904. 8vo.; pp. 768; 427 cuts. Price, $3.50.

The author of this textbook, in his capacity as Professor of Physics and Director of the Physical Laboratory of the Johns Hopkins University, has had a wide experience, and knows well the needs in treating of the subject in hand. Believing that the most important element in a physics course is a textbook which states the theory of the subject in a clear and logical manner, he has endeavored to give concise statements of experimental facts on which the science is based, and to present with these statements the accepted theories which correlate or explain them. The work is divided into six sections, as follows: Mechanics and Properties of Matter, Heat, Vibrations and Waves, Sound, Light, Magnetism and Electricity. Each of these sections is treated in a very lucid manner, and illustrated with numerous diagrams of experiments and pictures of apparatus. No experiment or observation which has an important bearing upon the subject in hand has been omitted, and the book is so thoroughly up-to-date as to mention the recent discovery of the decomposition of radium into helium. We most heartily recommend the book for use in schools and colleges, as well as for a general handbook of physics.

In English Homes. The Internal Character, Furniture, and Adornments of Some of the Most Notable Houses of England Historically Depicted from Photographs Specially Taken by Charles Latham. London: George Newnes, 1904. Imported by Charles Scribner's Sons, New York. Folio; pp. 453. Price, $15.

The historical castles and mansions of England have ever been a favorite subject for the historian, the romanticist, and the artist. From the time, sixty years ago, when Nash published that justly renowned book "Mansions of England in the Olden Time" down to the appearance of the truly magnificent volume "In English Homes," which forms the subject of the present notice, the historic homes of England have been made more or less familiar to the world at large, through the agency of pen and pencil. It must be confessed, however, that it was not until the photographic art had attained something of its present excellence that the glories of English domestic architecture of the grander sort and of the art treasures which it enshrined, began to be known outside of the limited few that had the opportunity to study the subject in the capacity either of guest or casual visitor. It was inevitable that such photographic illustration of the subject as was done should be concerned mainly with exteriors; and while the public is fairly familiar at least with the external architecture of the most prominent of the mansions and castles of England, it is certain that many of the interiors have hitherto been a sealed book. It was, therefore, a happy inspiration that prompted the English publishers to undertake the formidable task of gathering in a single volume a series of views of the interiors of the most notable mansions of England and making the work, by virtue of its size, voluminous contents and really superb letterpress and engravings, to say nothing of the luminous historical text, fully worthy of the subject. The illustrations, in particular, bring one into such intimate touch, not merely with the broad sweep of these grand interiors, but with the intimate details of their decorations and furnishings, that in this work the engraver and printer seem to have reached the very acme of their art.

The appearance of this work at a time when Messrs. Munn & Co. are bringing out a volume dealing in similar manner with the great homes of America, is peculiarly opportune, inasmuch as the one forms a complement to the other. Together they cover very completely the broad subject of the grander domestic architecture of the two great branches of the English-speaking race.

"In English Homes," contains 453 pages, 11 x 16 inches in size, of heavy plate paper, and over 500 engravings, more than half of which measure 8 x 10 inches and have an entire page to themselves. The plates are in themselves superb specimens of the photo-engraver's art; and the selection of interior views has evidently been made, as indeed we are told in the historical introduction, by one to whom the work has been in the fullest sense a labor of love. The opening chapter is devoted to an historical introduction in which it is shown that the history of the domestic life of the aristocracy of England from feudal times down to the present day can very clearly be traced in the gradual development to its present perfection of the typical manor house and castle. The central feature of the Saxon house and Norman castle was the great hall, which was the place of living, eating and daily business of the feudal family. The hall of the Tudor or Stuart gentleman is the more modern form of the hall of the Norman baron, and the long galleries and withdrawing rooms of later centuries were the outward expression of the growing refinement and good taste which led the lord and lady to seek for a larger measure of retirement from the common throng. The story of the gradual evolution of the leading features of the modern great house such as the hall, the long gallery, the grand staircases, etc., is lucidly and most beautifully told in the splendid series of engravings that enrich this volume.

The Ainu Group at the St. Louis Exposition. By Frederick Starr. Chicago: Open Court Publishing Company, 1904. 8vo.; pp. 118; illustrated. Price, 75 cents.

This interesting little volume contains a simple narrative of the author's journey in Yezo, and a description of the group of Ainus which he brought back with him for exhibition at the St. Louis Exposition. The various features of Ainu life are described, and the book is well illustrated with characteristic Ainus, their clothes, headdress, weapons, etc.

Electric Furnaces and Their Industrial Applications. By J. Wright. New York: The Norman W. Henley Publishing Company, 1905. 8vo.; pp. 288; 57 illustrations. Price, $3.

This work, which we believe is the only American work on the subject, is of timely interest, owing to the rapid development of electrochemistry in the past few years. The book opens with a brief historical sketch of the

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electric furnace. The succeeding chapters then describe very clearly the working principles of various types of furnaces, including many which have not yet passed the experimental stage. Electrolytic furnaces, though not strictly coming under the head of electric furnaces, are also described. The illustrations are in almost every case sectional diagrams, thus showing very clearly the different constructions.

THE WORLD'S WORK. St. Louis Fair Number. New York: Doubleday, Page & Co., 1904. 4to; pp. 200; numerous illustrations. Price, 50 cents.

The special Exposition number of the World's work, published last August, contains numerous fine half-tone illustrations of typical scenes at the St. Louis Fair, as well as articles on the Fair and what it commemorates; a new epoch in the use of power; transportation and the measure of progress; the people as an exhibit; Philippine peoples; Japan's extraordinary exhibit; the inspiring displays of the States; exhibits of pictures and sculpture; improvement of education; strange races of men; panorama of forestry, fish, and game; modern mining and its progress, etc. The number forms one of the best high-class publications on the World's Fair that we have seen.

INDEX OF INVENTIONS

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Electric switch, E. A. La Har 776,855
Electric switch, T. A. Cameron............... 776,998
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Starch, laundry, Reckitt & Sons .. 43,821, 43,822
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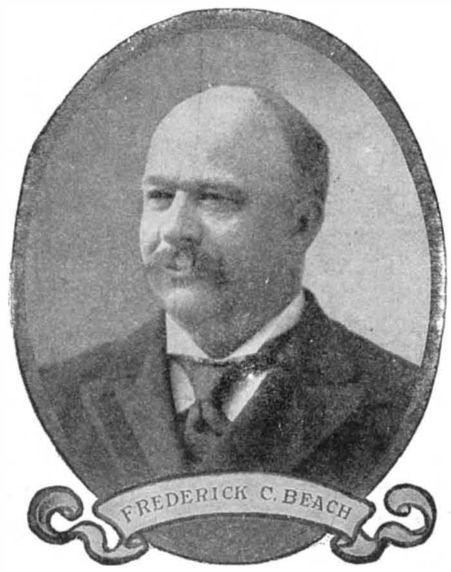

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