SCIENTIFIC AMERICAN

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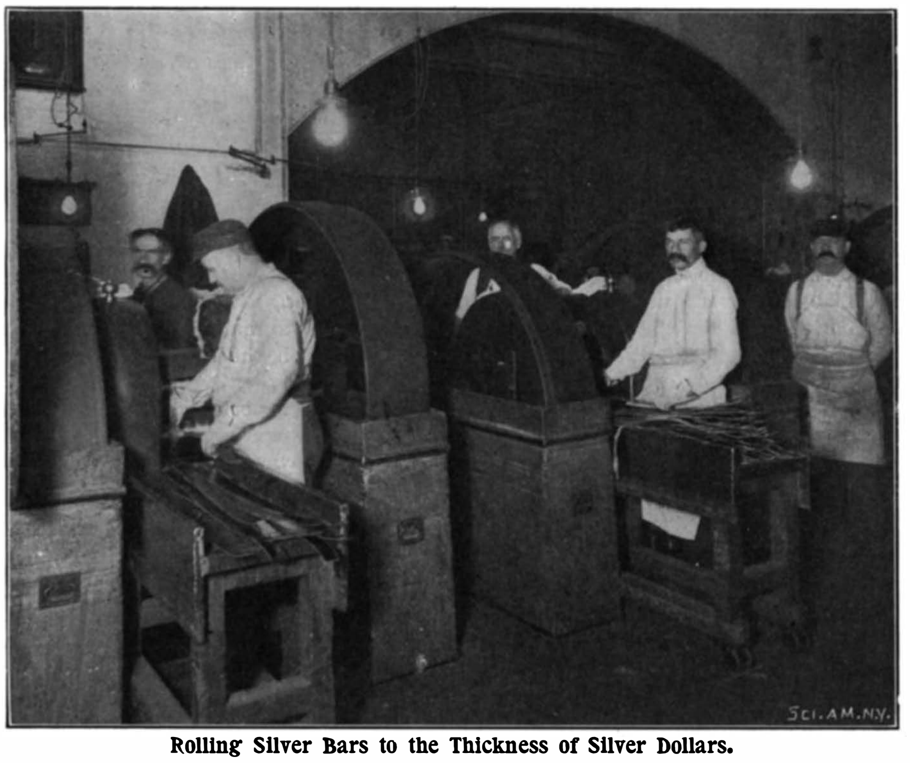
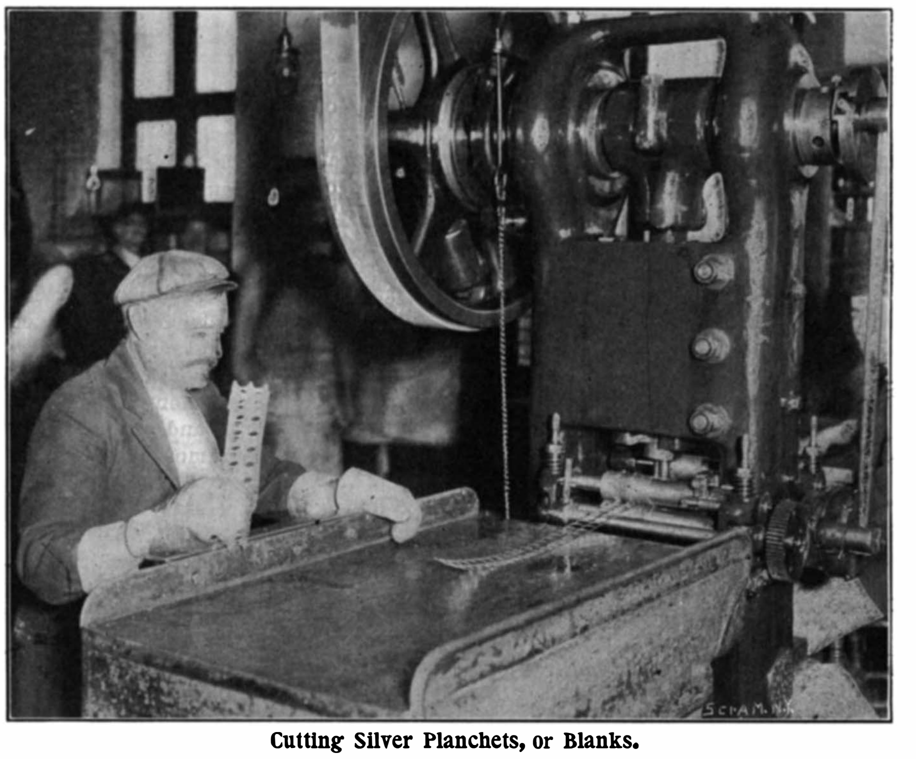
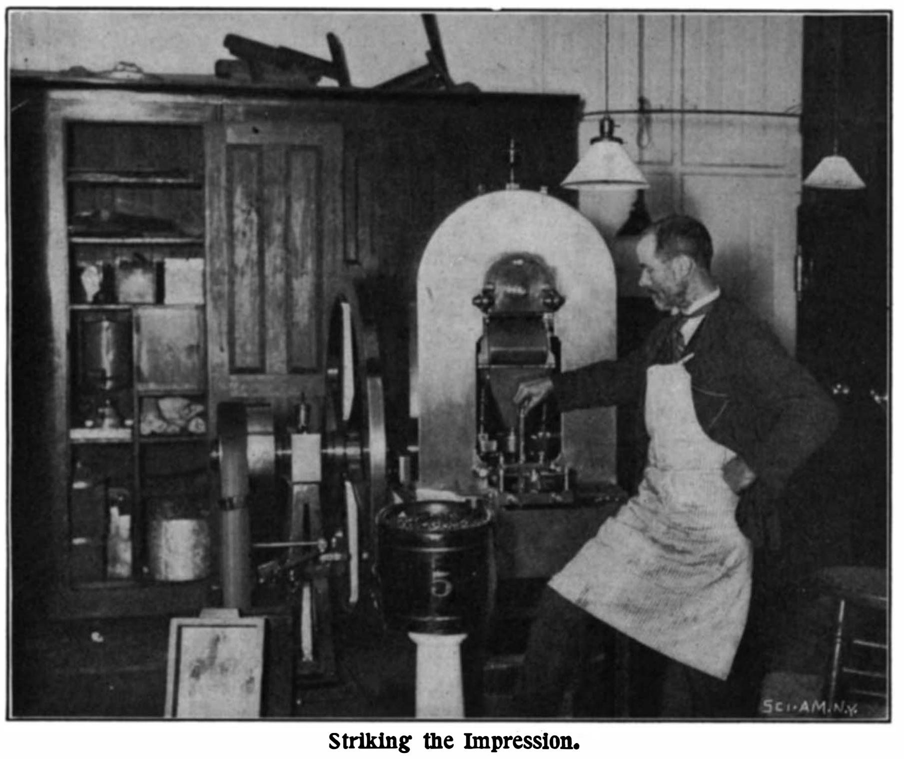
$50,000,000 in Gold Bars.


Casting Silver Bars.


Rolling Silver Bars to the Thickness of Silver Dollars.


Cutting Silver Planchets, or Blanks.


Striking the Impression.


Counting Cents.

THE MANUFACTURE OF COINS AS CARRIED ON AT THE UNITED STATES MINT, PHILADELPHIA, PA.—[See page 154.]

Scientific American.

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NEW YORK, SATURDAY, SEPTEMBER 7, 1901.

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.

A PROMISING TYPE OF GUN.

We call particular attention to an article on another page describing a new system of gun construction which, both theoretically and by actual test at the Government proving grounds, gives promise of showing superiority over every other type of gun on all possible points of comparison. It is now some four years since we described the manufacture of the 10-inch segmental, wire-wound gun, which was being built by the United States Government for the purpose of determining the value of that system of construction. Since that time a 5-inch, rapid-fire, type gun has been constructed, embodying certain radical improvements, but built on the same basic principles; and both weapons have undergone tests at Sandy Hook. Although the ballistic powers claimed for these guns were far in excess of anything that had been obtained in gun construction, the Sandy Hook tests, as far as they have been carried out, have fully substantiated these claims; and although, in the case of both guns, there have been accidents or interruptions to the tests which might seem at first sight to cast a doubt upon the efficiency of the system, a careful study of the reports and the results shows that these drawbacks have been due to what might be called accidental or external circumstances—such as failure of the gun carriages or changes in powder—and that in no case have they been due to faults either in the construction, the theory, or the guns themselves.

From the official reports on these tests, we gather: First, that the 5-inch Brown gun tested at Sandy Hook in 1893 and 1894 gave a 61-pound projectile an instrumental velocity of 3,194 feet per second, the muzzle velocity being 3,235 feet per second. It is a fact that, after an interval of seven years, this velocity has not been equaled in any gun of a practical length. The report states that a pressure of 82,850 pounds in the chamber of the gun was reached during this test—a pressure which, it must be admitted, would certainly destroy a gun of any other type built in this country. Compared with our new navy 50-caliber 5-inch gun, we find that that weapon has given its 60-pound shell a muzzle velocity of 2,990 feet per second, developing a muzzle energy of 3,710 foot tons, or about 832 foot tons energy per ton-weight of gun. The segmental, wire-tube 5-inch gun, 44 calibers long, when it reached the remarkable velocity above referred to, developed a muzzle energy of over 4,432 foot tons, or 1,055 foot tons of energy per ton of gun. The 5-inch type of gun tested in 1899 fired 300 shots for endurance under a contract which called for a velocity of 2,600 feet per second. The firing sheet turned in by the ordnance inspector who superintended the tests shows that all but three of the last ten shots were fired with velocities of 2,700 feet per second, which proves that, even after 300 shots with smokeless powder, the erosion had not been sufficient to affect the velocity.

As regards the ultimate strength (the ability of the gun to resist bursting effects due to wave action and other irregularities of the powder), it may be mentioned that the original 5-inch gun of 1893 and 1894 was sent to Sandy Hook to be tested by firing 500 shots with pressure between 40,000 and 50,000 pounds to the square inch, the latter being the maximum pressure to which it was to be subjected. The Ordnance Board, wishing to experiment with a new type of smokeless powder, ran the pressure up as high as 82,850 pounds per square inch, as mentioned above, and fired from the gun more shots at pressures of 50,000 pounds and upward than have been endured by all the built-up, hooped guns in the army. At the 292d shot it was found that the repetition of the extravagant charges used in the gun had cracked one of the segments. Nevertheless, although the gun had fired several shots with 50,000 pounds pressure after the cracking of the segment, it was not until the gas cut its way through the wire that the injury was discovered. This remarkable fact is a conclusive proof of the theory that the segmental system of construction, especially with curved, overlaid plates as now used, will permit a fracture of one of the segments without threatening the integrity of the gun itself.

As regards the ultimate possibilities of the system, it may be mentioned that a 4½-inch gun is now being constructed which will be capable of firing an extra-long 55-pound projectile, with a muzzle velocity of just under 4,000 feet per second. The ballistic data for this particular gun have been calculated by Lieut.-Col. James M. Ingalls, U. S. A., and he estimates that when fired at extreme elevation, and with the weight of shell and the muzzle velocity given above, the gun will have an extreme range of 23.9 miles, or just 3 miles more than the range of 20.9 miles estimated by the same authority as the extreme range of the Army 16-inch gun, now nearing completion. This estimate is based upon an assumption of a chamber pressure of 60,000 pounds to the square inch. If the calculations of Col. Ingalls should prove to be correct—as they undoubtedly will—and the 4½-inch gun prove itself equal to the enormous powder pressures demanded, the United States will be in possession of a weapon so far in advance of existing types as to be distinctly in a class by itself.

It is sincerely to be hoped that, in the further government tests which have as yet to be made of this system, every possible facility will be afforded for trying it out to the utmost limit of its capabilities.

SOME CHEMICAL MYSTERIES.

It has happened more than once that just as we had firmly established our sciences upon a basis which seemed as unyielding as the Biblical rock, and had toilfully formulated theories that explained all phenomena with unvarying simplicity, some obscure experimentalist made a discovery which by no possibility could be twisted and molded to fit the existing system and, indeed, even challenged the truth of all established doctrines. Thus it was that Young and Fresnel overthrew the old emission theory of light with their experiments in the phenomena of interference; and thus our theories of chemical interaction, and even our conception of matter, may be modified by the researches made within the last few years in the field of the radio-active substances.

What chemist formerly would for a moment have thought of attacking the law of Avogadro—the law which tells us that if the temperature and pressure be equal, equal volumes of different gases contain the same number of molecules? And yet a modern chemist, Lord Rayleigh, did find it necessary to test the truth of that law by precise determinations of the densities of well-known gases. If he had never studied the behavior of nitrogen, or if he had considered the discrepancies which he observed in determining the vapor density of that gas, as errors due to defective observation, as many a chemist before him had done, argon and the other newly discovered constituents of the atmosphere might still be unknown, and many chemical doubts never aroused. Roentgen, too, found it necessary to revive theories of radiant matter which we thought we had long since refuted, and he supplied us with rays which we cannot yet explain. Becquerel increased our perplexity with his thorium and uranium rays. But when M. and Mme. Curie exhibited to our astonished eyes the results which they had achieved with radium and polonium, we were completely mystified and were compelled to admit that there were more things in chemistry than our philosophy had dreamed of. Other chemists have also experimented with uranium, following methods different from those of the Curies, and have obtained additional active substances.

Still another supposed element has been found to mock our periodic system. It has been discovered that thorium, when subjected to the action of acids, yields helium, and that thorium is often associated with radio-active substances.

Helium and its gaseous companions on the one hand, the radioactive substances on the other hand, are mysteries which have so far completely baffled our chemists. And uranium and thorium, elements with which we once considered ourselves thoroughly familiar, are now to us as curious as if they had been but the discovery of yesterday.

If the eccentricities of uranium, thorium and helium, and the mysteries of Roentgen rays cannot be adequately accounted for by our existing chemical system, the question arises: Can our system be wrong? Chemistry is an exact science—at least we had flattered ourselves that it had been at last raised to that eminence. But an exact science is infallible, and will hear nothing of exceptions. Some day a chemist will be found whose mind, broad enough to grasp the scattered facts unearthed in the course of a century of research, will elaborate a chemical system which may prove as revolutionary in its way as the theory of Young; but which will embrace in its comprehensiveness those puzzling gases and radiant substances so utterly inexplicable at present.

THE DESIGN OF PROPELLERS.

The whole system of screw propulsion used upon the turbine vessels does not conform to that of other high-powered ships, for the screws are not only greatly multiplied in number but they are exceedingly small in diameter, and, judged by the proportions used in regular practice and by the eye as well, would seem to be wholly incapable of achieving such good results. In the recent tests of warships, or boilers for them, the commander of one vessel was urged to order a higher rate of revolution in the engines of one vessel to increase the speed, but he is said to have replied that it would be of no use, inasmuch as the screws would "only churn the water." As regards "churning," so-called, this is an old argument against screws; they may "churn," as it is called, but if they do the more they churn (or turn) the faster the vessel they are in goes. The "Ellide," the fastest steam yacht afloat to-day, has run at the rate of forty miles an hour on the measured mile; to do this her screws ran at over 800 revolutions per minute, and they are only 42 inches diameter at that. If the churning, so called, was a serious hindrance to efficiency, the vessel certainly could not have maintained any such velocity.

Some discussion of this subject of screw propellers, occurred at the late meeting of the Institution of Naval Architects, England, and an elaborate paper by a Russian engineer, Mr. Drzewiecki—mathematical from start to finish—was adverted to. Briefly, the paper contained two propositions, the first being that there was a certain form of screw having a mean pitch of 1.25 times the diameter, with the pitch disposed in a particular way, which gave better results than any other form. The second proposition was the first repeated, to wit: if the premises were correct that was the kind of screw for general use, and no other, so that one drawing of a screw would suffice for all, the only variation being in the number of blades and the size and number of the propellers to suit different cases.

This is exactly what is now done in this country, and, we may add, in other countries, but it seems to beg the whole question and leave it where it was. Two ships are built upon the same molds and with the same engine powers and screws, but it is found in practice that they do not perform alike; in other words, one vessel is better than the other, and the screws act differently. The why and wherefore of this variation is what all persons interested would like to find out, but as yet no one has. In the discussion above referred to, it was stated that Mr. Froude found, to his surprise, that there was no advantage in one pitch ratio over another, through a very wide range. The principal difficulty in screw design laid in correctly estimating the velocity of the wake (its wake) and the propulsive effect. Prof. Biles was of the opinion that the proposal to make a uniform propeller struck him as being much the same as an effort to make a uniform ship.

The results of years of experiment and research by careful and experienced observers go to show that the propeller cannot be laid down upon hard and fast lines, but that it must be eliminated, so to speak, from many observations upon ships for certain purposes. It is quite true that a vessel may not perform satisfactorily with a standard screw, so-called, or one built after usual methods, and do much better with a bastard screw of no known principles or derivation. This will account for the many testimonials from owners which aver that a certain wheel improved the speed of their ship so many miles an hour over the old wheel; although the increase is usually put far too high, seeing that it has been asserted by good authorities that, as between the very worst and the very best screw that could be designed the difference is not 10 per cent.

MARCONI TELEGRAPHS ON THE BRITISH FLEET.

The recent naval maneuvers of the British navy have emphasized the advantages and disadvantages of the Marconi system of wireless telegraphy when applied to battleships. In the recent French maneuvers complaints were made that messages transmitted between the vessels of the French squadron were intercepted by the English vessels. The same result has occurred during the English maneuvers. One squadron was enabled to receive all the messages that were transmitted between the vessels of the opposing fleet, and was enabled to act accordingly. The messages were, of course, transmitted in code, but the eavesdropping fleet succeeded in deciphering the cryptograms after a little study. The tinkling bell of the instruments upon the various battleships worked as readily as if the messages were intended for those particular receivers. On one occasion messages were intercepted at a distance of 80 miles from the transmitting vessel. The explanation is that the Hertzian waves, as they are transmitted, radiate in all directions in the same way that the ripplings spread over a lake and affected all instruments with which they came into contact. Such a *contre-temps* would be very disastrous in actual fighting, though to a certain extent their utility would be nullified by the utilization of the secret code, without any more danger than would arise from the transmission of signals by means of the semaphore. It was discovered that the system was unworkable unless conducted by the most expert operators, so delicate are the adjustments that have to be made from time to time. An instrument tuned up for a distance of 20 miles was found to be equally efficient at a distance of 50 miles. Marconi has devoted his energies to the remedying of this salient disadvantage of the system, and states that he is now able to minimize, or to obviate entirely, any possibility of such leakages. The presence of land, and the condition of the atmosphere, was proved to materially affect the intensification of the electric impulses and the accuracy of the signals.

PAN-AMERICAN MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

BY WILLIAM H. HALE.

The Buffalo meeting of the American Institute held in the New York State Building at the Pan-American Exposition was notable both for the papers presented and the international character of the attendance. Last year the institute met at the Paris Exposition, and invited European engineers to attend this meeting. Over 4,000 invitations were sent out to all the prominent engineers of Europe; and though only about fifteen persons responded the foreign delegation included representative men from France, Belgium, Germany, England, South Africa, Hawaii.

The impressiveness of this meeting was emphasized by its environment. The triumph of electrical engineering was conspicuous at the fair, and in all the surrounding region, in the utilization of Niagara for power and light and vast electrolytic works.

The foreign guests were welcomed to New York by President Charles P. Steinmetz at the house of the American Society of Mechanical Engineers, and went by special train to Buffalo, stopping to examine the great works of the General Electric Company at Schenectady, which are under the management of President Steinmetz.

The exercises of the first day at Buffalo consisted merely of an address of welcome by Prof. George F. Sever, chief of the electrical department of the fair. Papers were read on each of the other days. Thursday, which has been designated as Electrical Day, was distinguished by a lack of electricity, causing an interruption of two hours to the illumination that evening.

Papers read include the following: Paul M. Lincoln described a frequency indicator of his own invention now used in the Niagara Falls Power House. It tells whether the machine being synchronized runs too fast or too slow; also it tells the exact place of synchronism.

Caryl D. Haskins, in his paper on "Electric Meters," said that recording meter design has progressed rapidly, so that no such radical improvements may be expected now as formerly. The two essentials meriting most careful study are: First, the expenditure of the maximum permissible amount of work in the foucault disk, and, second, the provision of the best means for instantly compensating for friction variation at the point of use without affecting total calibration.

William H. Browne, Jr., read a paper on "Power Factor Indicators," constructed to show that the wattless component of current due to induction motors is balanced by the use of synchronous motors or converters. The use of such an instrument shows that when induction motors are used alone the inductance factor is always a large percentage of the power factor; and he says that those who use induction motors should at least pay rental for the wattless volt amperes required. The ensuing discussion developed a general sentiment in favor of charging rental for power thus borrowed, even though afterward returned.

Thursday, August 15, "Electrical Day," was taken up with papers and discussions on "The Transmission of Power." E. W. Rice, Jr., described an oil break of his invention now employed by the Metropolitan Street Railroad Company of New York, which retains the usual advantages of the oil switch and minimizes the amount of oil required. This safely controls currents of practically unlimited power at potentials considerably above 40,000 volts, probably as high as 100,000 volts.

President Steinmetz presented a theoretical investigation of some oscillations of extremely high potential in alternating high potential transmissions, in which by elaborate mathematical processes he worked out several conclusions, the most important of which is thus stated: "The electric oscillations occurring in connecting a transmission line to the generator are not of a dangerous potential, but the oscillations produced by opening the transmission circuit under load may reach destructive voltages, and the oscillations caused by interrupting a short circuit are liable to reach voltages far beyond the strength of any insulation. Thus special precautions should be taken in opening a high potential circuit under load. But the most dangerous phenomenon is a low resistance short circuit in open space."

F. A. C. Perrine, in his paper on "Elements of Design, Particularly Pertaining to Long Distance Transmission," called attention to the different nature of the problems involved in great and in small installations, due to the fact that mechanical factors of safety must be more carefully considered, because good insulations are never materials of great strength and can be relied on for their mechanical properties only when the mechanical strains are comparatively unimportant.

Charles F. Scott read a paper on "The Induction Motor and the Rotary Converter, and Their Relation to the Transmission System," in which he maintained that these two kinds of apparatus represent the survival of the fittest, and confirm the judgment of engineers who have advocated them, because they best fulfill the two important functions of an alternating current transmission system; namely, the production of mechanical power and the furnishing of a direct current.

On Friday, August 16, Lewis B. Stillwell gave an elaborate account of the Niagara Falls transmission plant, by far the longest paper read. The company are now building a new power house for 55,000 horse power. The most striking point of the paper was the statement that the improvements made in the new house were mainly in the hydraulic and but slightly in the electrical equipment, proving that for nearly a decade electrical engineering has been established upon a basis as certain and permanent as other branches of engineering; that eight years ago it was possible so to plan an electrical installation involving ultimately the transmission and distribution of several hundred thousand horse power; that at the present time we can effect improvement only with respect to relatively unimportant details, the aggregate results of which, if adopted, would be hardly noticeable as affecting the cost of power. The resulting economy of power would not amount to one dollar per kilowatt year.

"The Development of the Nernst Lamp in America" was presented by Alexander J. Wurts. A striking exhibit of these lamps is made by the Westinghouse company in the Electrical Building, the entire dome being lighted by them. It is said that the lamp has passed beyond the experimental and has fairly reached the commercial stage. The light, brighter and purer than that of the incandescent lamp, has nearly the spectrum of sunlight; yet it costs but half as much as the incandescent. The lamp has been described in the SCIENTIFIC AMERICAN. Mr. Wurts recapitulates its advantages as being absence of shadow, steadiness of light, simplicity and low cost of maintenance, high efficiency of the lamp, and the fact that it is operative on 3,000 alternations.

Saturday, August 17, was devoted to electric railways, with two papers and much discussion. Albert H. Armstrong read "Notes on Modern Railway Practice," with special reference to long distance and either high speed for passenger or great power for freight trains. The best equipment for both is a mixed system, combining third rail and overhead trolley.

Ernst J. Berg read a paper on "Electric Railway Apparatus." He favors for general use the direct current and rotary converter, though admitting that there is a field for alternating-current motors, but it is strictly limited to long distance schemes, or to mountain roads.

Messrs. Janet, of France, and Jaenisch, of Germany, both speaking in their own language, agreed that the three-phase system found most favor on the continent.

President Steinmetz replied that while the General Electric Company were building a three-phase installation for a North Italian road, they had never been able to secure an experimental use of that system in America, even when they offered it to builders at cost price.

A member in discussing the subject stated, on the authority of a railroad official who has been using electric traction for five years, that the cost of hauling freight by electricity is less than by steam.

An invitation was received to meet next year at Great Barrington, and indications are that the council will accept it.

EXTERMINATION OF THE MOSQUITO.

BY JOHN CHAMBERLAIN.

I am convinced that the renewed pursuit of the mosquito, which science is making with so much apparent promise of late, is a mistake in at least one important particular. I shall have to confess that my conclusion is in great part inferential, but it seems so positive that it ought to merit at least more than a passing consideration. The accounts of the habits of this insect all stop short of what is plainly the fact in regard to the life of the larvæ, which I am sure that I can demonstrate, if only in a semi-negative fashion.

I cannot avoid the conclusion that this insect, assuming that this region is the habitat of certain species of Culex, does not confine itself to standing water for the hatching of its eggs and the development of the larvæ, but when that is wanting, is able make the shift of using thick grass and the soil and decaying leaves of heavy forests. To a certain extent this is also true of frogs, and especially the common garden toad. This latter has made its appearance this summer in my city yard, where there has not been a toad for many years and which is far from any standing water. The specimens were of this year's growth.

The mosquito does not always need to resort to moist, loose and shaded soil for the propagation of its species, and in such seasons it is less numerous there than in dry seasons. During the past three seasons I have had an especially good opportunity to note this fact, though unfortunately the conviction of it has come to me so lately that I have not carried the matter to an actual demonstration. During the seasons of 1899 and 1900 there has been a severe drouth, beginning so early that there was no standing water anywhere near us. We did not have water enough for the stock and domestic purposes, and there was not a drop of standing water anywhere in our vicinity till after the mosquito season was over, yet we never had so many of them about the house and garden as then, and the woods were swarming with them. I recall being driven out of the garden one day, where I had been at work near a heavy grass plot, heavy on account of previous washings from the barnyard.

This has not happened this year, though there has been so much rain during the mosquito season of June that it was difficult to work uplands, and lowland cultivation had to be abandoned till July The inference is unavoidable that the mosquito was content to make headquarters in the swamp districts when there was standing water there sufficient for its purposes, and when that failed there was nothing to do but make a selection of the most favorable dry lands, such as heavy grass plots and deep woods. Nobody who saw the myriads of these insects in such places during the late dry seasons could have the least doubt that they were hatched out there, for where else could they have come from? And at the same time the much smaller showing during the present wet season was good evidence that the insect had remained in its favorite reproducing localities.

Now as to the bearing of this point on the proposition to exterminate, or at least greatly thin out, the mosquito by kerosene applications. It will be seen that though the effort may meet with some success where marshes are regular every June, there can be very little done in dry sections, or still worse, occasionally dry ones. The scourge is not by any means so severe in such localities as it is near marsh lands, but it is quite often of considerable account and quite enough to neutralize the effort to stop the spread of malaria and yellow fever by that means, for it will surely be found that if the mosquito can reproduce itself in temperate regions without the use of standing water, it can do so much more easily in the tropics, where the light soil is deeply covered with undergrowth and the shade is deep. In such places the food of the larvæ, decaying vegetable matter, is abundant.

American Association for the Advancement of Science.

The fiftieth annual meeting of the association opened on August 26 at Denver, Colo., with an attendance of nearly 200 members, and the city of Pittsburg, Pa., was chosen for the annual meeting of 1902.

The general session was called to order by the retiring president, Professor R. S. Woodward, of Columbia University, New York, who introduced the new president, Dr. C. S. Minot, of Boston. Addresses of welcome were made by Mayor Wright, of Denver, and others. During the afternoon the new officers were installed.

The following vice-presidents made their farewell addresses: Vice-President Davenport, before the section of zoology, on "The Zoology of the Twentieth Century"; Vice-President Brashear, before the section of mechanical science and engineering, "The Carnegie Technical School"; Vice-President Butler, before the section of anthropology, on "A Notable Factor in Social Degeneration"; Vice-President Long, before the section on chemistry, on "Some Points in the Early History and the Present Conditions of the Teaching of Chemistry in the Medical Schools of the United States," and Vice-President Woodward, before the section of social and economic science.

Several express cars are now in use on the surface lines in New York city, the old mail cars of the Third Avenue road being used for the purpose. Operations are under way to establish terminals in important places in Westchester County.

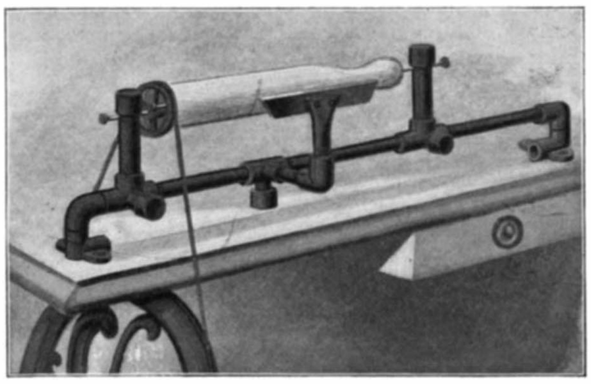
A SIMPLE HOME-MADE LATHE.

BY BUDD A. WRIGHT.

The boy of a mechanical turn of mind who finds that a lathe is a necessary part of his small shop equipment, and that he has not the necessary funds to buy one of the many foot-power machines advertised, need not be discouraged. It is easy enough to make a lathe which will meet all his simple requirements.

The bed of such a lathe consists of a piece of 3/8-inch pipe to each end of which a straight L is screwed. On each L an elbow is screwed, having flanges pierced to receive screws whereby the base may be secured to the table of a sewing-machine. The poppets can be made of a four-way 1/2-inch T, slipped over the 3/8-inch pipe and fastened thereto by a piece of 3/8-inch pipe about 1/2-inch long inserted through one of the holes of the T. A 1/2-inch plug screwed upon this arm of the T will force the 3/8-inch pipe tightly against the bed-pipe and hold the poppet rigidly in place. In the remaining arm of each T a piece of 1/2-inch pipe is screwed. Through the upper end of one of these 1/2-inch pipes a hole is drilled, parallel with the bed. The hole receives a wire nail (the point of which has been rounded off with a file) serving as the arbor of a pulley which is belted to the driving-wheel of the sewing-machine. A wire nail is similarly journaled in the 1/2-inch pipe of the other poppet. Between the two nails the object to be turned is held. To impart rotation to the work a nail is partly driven into the work between two spokes of the pulley.

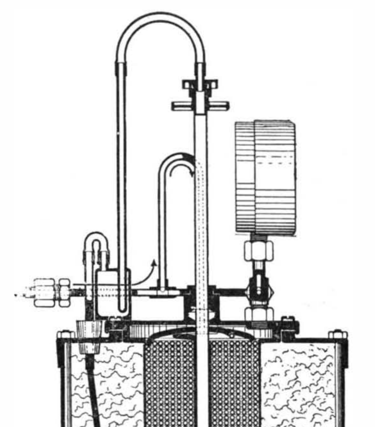
The tool-rest consists of two parts, 3/8-inch piping being used. One part is carried on the bed-pipe, and is screwed to the second part. A piece of band iron is riveted to the top of the second part and serves as a tool-rest.



A HOME-MADE LATHE.

A LABORATORY APPARATUS FOR LIQUEFYING GASES.

The various methods employed before 1895 by the original investigators for liquefying those substances which yield up their gaseous forms with great difficulty, have all been displaced by a most simple method which was apparently discovered by Siemens and described in the preliminary specifications for an English patent in 1857. "The invention relates to freezing and refrigerating by the expansion of air or elastic fluid. The air is first compressed by a cylinder, or by pumps of any suitable construction, by which the temperature is raised, and it is cooled while in the compressed state, and then allowed to expand in a cylinder or engine of any suitable construction, by which the temperature is lowered. The air thus cooled . . . . is then conducted through an interchanger, or apparatus by which it is made to cool the compressed air which enters the interchanger in the opposite direction, . . . The principle of the invention is adapted to produce an accumulated effect, or an indefinite reduction of temperature."* This description might almost be used without change of any of the machines which have attracted attention here and abroad during the last six years. Several ice-making machines were constructed upon this principle between 1863 and 1874, in which the water was frozen by the expansion of air.



SECTIONAL VIEW OF GAS LIQUEFYING APPARATUS.

In 1874 our own Prof. Edwin J. Houston suggested the use of such a method for the liquefaction of the incoercible gases. "There would appear to be no other limit to the reduction of temperature save what would arise from the strength of materials, or the liquefaction and subsequent freezing of the nitrogen, or the oxygen of the air, or of the air itself.* In 1877 Cailletet and Pictet liquefied oxygen and nitrogen by methods unlike this; but the apparatus suggested by Prof. Houston is a clear anticipation of those of Linde, and Hampson, made public in May, 1895, and of Mr. Tripler which attracted public notice in 1897. All of these machines have been described and illustrated in our columns.

We present at this time an account of a form of Dr. Hampson's liquefier, designed so that it should be available for use in any laboratory, and also of moderate cost. It is claimed for it that it will begin to deliver liquid air in from 6 to 10 minutes after the admission of air, at from 150 to 200 atmospheres pressure, and will make over a liter of liquid per hour. The liquefier seen on the stand is a cylinder 17 inches high and 8 inches in diameter. With a compressor which can deliver air at or above 100 atmospheres it will work continuously day after day. When a compressor is employed the purifiers are used. The large one, standing on the floor to the right, is of low pressure; the small one under the liquefier to the left of the stand is of high pressure. Without a compressor the gas is delivered to the liquefier from cylinders, similar to our cylinders for containing oxygen and hydrogen for the stereopticon, and in such use no purifiers are needed. In this case the coils of the liquefier are first cooled by the expansion of liquid carbon dioxide, in the return pipes, surrounding the air under pressure previous to its expansion.

The essential feature in this, as in all machines of its class, is seen in the sectional view. The air under pressure flows in at the top on the left and traverses one system of pipes, whose numerous convolutions occupy most of the space within the packing, returning by the reverse system of pipes to go out into the open air. With a compressor there is no reason why this expanded and dry air may not be taken in and compressed again, thus saving some work for the purifying apparatus.

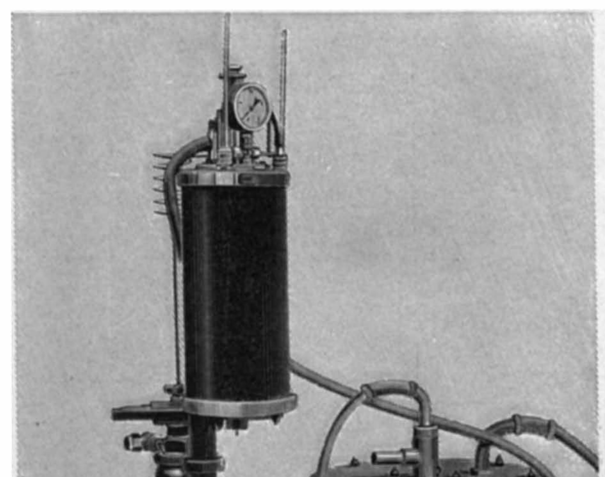
The expansion valve is seen at the bottom of the liquefier. The efficacy of the machine depends wholly upon the Joule effect, and no increase of cooling is brought about by compelling the expanding air to do work. This could hardly be expected in so small a machine. The Joule effect is, however, inversely proportional to the square of the absolute temperature; a fact which accelerates the action as the air grows colder. Thus expansion of air from 4½ atmospheres to 1 will cool the air from 0 deg. C. to 1 deg. below 0 deg. C.; that is, from 273 deg. to 272 deg. absolute temperature. But at two-thirds of that absolute temperature, at 182 deg. below 0 deg. C., or which is at 91 deg. absolute, an equal drop of pressure will produce a cooling represented by two-thirds squared and inverted, or nine-fourths as much, which is 2¼ deg.

The points of merit claimed for the apparatus are a large surface of exposure between the compressed inflowing and the expanded outgoing air, as little separation as possible between these streams, and this of as high a conducting value as possible; having a small quantity of air in action at once. To attain these ends the pipes are of copper in close contact with each other, of small bore and of little thickness. These thermal advantages have been so carefully attended to that this is considered one of the most efficient hitherto designed.

With supplementary arrangements even hydrogen has been liquefied by it. Numbers of these are in use in university laboratories in various countries, and some have been brought to the United States.

* Harden, "Liquefaction of Gases," p. 182, $1.50.

* Jour. Frank. Inst. 1874, p. 9 et al.



LABORATORY APPARATUS FOR LIQUEFYING GAS.

Iron and Steel Production of the United States.

The American Iron and Steel Association, in a report recently issued, states that the total production of pig iron in the first half of 1901 was 7,674,613 gross tons, against 7,642,569 tons in the first half of 1900, and 6,146,673 tons in the second half. The production of Bessemer pig in the first half of 1901 was 4,582,187 gross tons, against 4,461,391 tons in the first half of 1900, and 3,482,061 tons in the second half. The production of basic pig iron in the first half of 1901 was 645,105 gross tons, against 581,868 tons in the first half of 1900, and 490,508 tons in the second half. The stocks which were unsold in the hands of manufacturers or their agents on June 30, 1901, amounted to 374,129 tons, against 442,370 tons on December 31, 1900, and 338,053 tons on June 30, 1900.

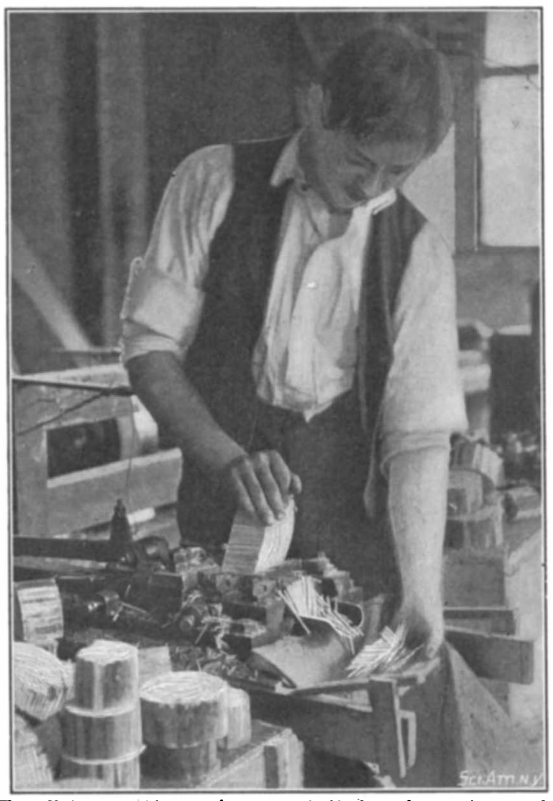
A Contemplated Balloon Trip.

Count Henri de la Vaulx, the famous French aeronaut who holds the world's record for having covered the longest distance in a balloon, contemplates some interesting experiments which, if successful, will be of more than general interest. He proposes to cross the Mediterranean from Toulon to Algiers, a distance of 496 miles. In point of mileage it is not so great an achievement as the one he accomplished last year when he went from Paris to Kiev in 36 hours. His main object this time is to ascertain whether it is possible to steer the ordinary spherical balloon. A special steering apparatus has been invented by M. Hervé. The steering appliance is not to be attached to the balloon itself, such as was the case with André, but is to float on, or to be submerged in, the water. The apparatus comprises a series of boards connected together and forming a combination of parallel helms. These will be towed by the balloon while submerged at a depth of about 15 feet below the surface of the water. To this arrangement is to be attached another appliance termed the "steadier," which is a kind of ship's keel floating on the surface of the water. This steadier weighs about 900 pounds. The balloon will be attached to this by a rope 300 feet in length, and the aeronaut opines that the weight of the steadier will prevent the balloon rising above that height. Beneath the car will be attached a zinc cask provided with a pump, from which extends a thin pipe communicating with the sea below. The idea of the aeronaut is to utilize sea water as ballast, the pump enabling the cask to be emptied or filled according to the exigencies that arise. The cask when full will weigh approximately 400 pounds. He will also carry a quantity of oil in case the sea proves boisterous, while he has observed the precaution to render his car waterproof and floatable should accident attend the experiment. The trial is to be semi-military in character. Complete signaling apparatus and powerful searchlights are to be carried, while he will be accompanied on the expedition by two lieutenants of the French navy. The various governments have been notified of the trial, so that the cutting of the balloon from her steering appliances may be averted. The scope of the trial is to prove that if, in the event of war, a hostile fleet occupied the Mediterranean at this point, France could still maintain communication with her African colony by means of balloons. The logic of this contention, however, appears to be irreconcilable, since an opposing fleet could capture or destroy the efficacy of such a service if such steering apparatus as that to be used on this trip were to be utilized. The projected voyage is to be made in September.

THE MANUFACTURE OF MATCHES.

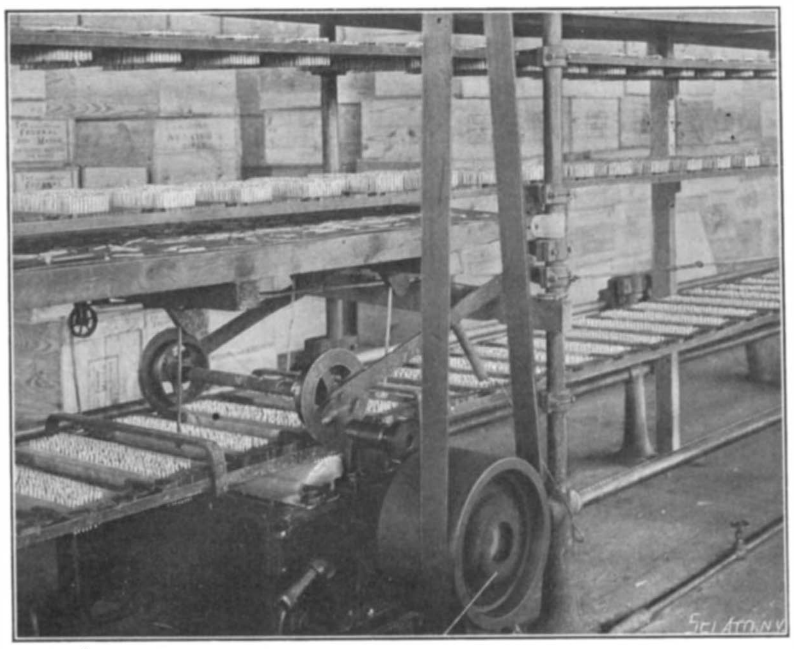
The match-making industry affords a striking instance of the great economy in time and labor which has been accomplished, particularly of late years, by the development of labor-saving machinery. Of the many articles that are necessary to the comfort of our domestic life, there are few that are produced and sold so cheaply as the common, tipped match. Were it not for the very ingenious machinery which has been specially devised for their manufacture it would be impossible to produce matches in such enormous numbers, and place them on the market at the astonishingly low price which prevails at the present time. The rapidity of manufacture may be judged from the fact that the machine shown in the accompanying illustrations, which is in operation in the factory of the Federal Match Company, Paterson, N. J., is turning out 18,000,000 matches per day of 20 working hours. The process of match-making, as carried out at the works of this company, may be broadly divided into the manufacture of the splints and the dipping of the splints in phosphorus to produce the finished matches. Although the present article is devoted more particularly to the match-making machine, we will trace the whole process from the rough lumber to the finished match as packed ready for the market.

Manufacture of Splints.—The raw material for the manufacture of "splints," as the diminutive sticks of wood which carry the igniting material are called, usually consists of a special grade of sawn lumber, the wood being chosen for the straightness of its grain and its freedom from notches. This lumber costs from $26 to as high as $50 per 1,000, board measure. In cutting the splints it is necessary that the grain should run parallel with the splint, otherwise the latter will snap in two when the match is struck. The impossibility of securing sawn lumber in which the grain is everywhere parallel with the board results in a considerable percentage of waste. To avoid this waste and to render it possible to use a cheaper grade of lumber, the Federal Match Company manufacture their splints from white-pine cordwood. The rough lumber, as soon as it is delivered at the works, is peeled, split, and stacked to dry. The split wood is then sawn crosswise of the grain into 2-inch lengths, and the splints are cut from these blocks in the specially-designed planing machine shown in the accompanying illustration. The planing tool of this machine consists of a double row of circular knives superimposed above one another, there being 32 of these little knives in each row. As the knife makes 250 strokes per minute, the capacity of each machine, allowing for time lost in picking up a fresh block, is nearly a million splints per hour. The splints are first dried by hot air, and then gathered up by boys and placed in the hopper of a cleaning machine, where all slivers or broken fragments are separated out. The cleaner consists of a hopper which delivers the matches onto the upper end of a sloping oscillating table, whose surface contains a number of parallel grooves, running in the direction of the oscillation. At intervals of a few inches transverse slots are cut entirely through the table. The match splints travel down the table and fall into a receptacle below, while the slivers and broken fragments fall through the slots. From the cleaning machine the splints are taken to a straightening machine, where they are shaken down until they arrange themselves side by side in long parallel rows, just as cordwood is arranged and stacked by the wood-cutter. The machine is then stopped and the slats drawn away, leaving the matches straightened out ready for further handling. They are picked up and put in "holders," little boxes 4 inches deep, 2 inches wide, and 15 inches in length. These holders are carried to the large match-making machine which forms the chief subject of our illustrations.



The splints are cut by a reciprocating knife from the two-inch blocks of cordwood.

PREPARING THE SPLINTS



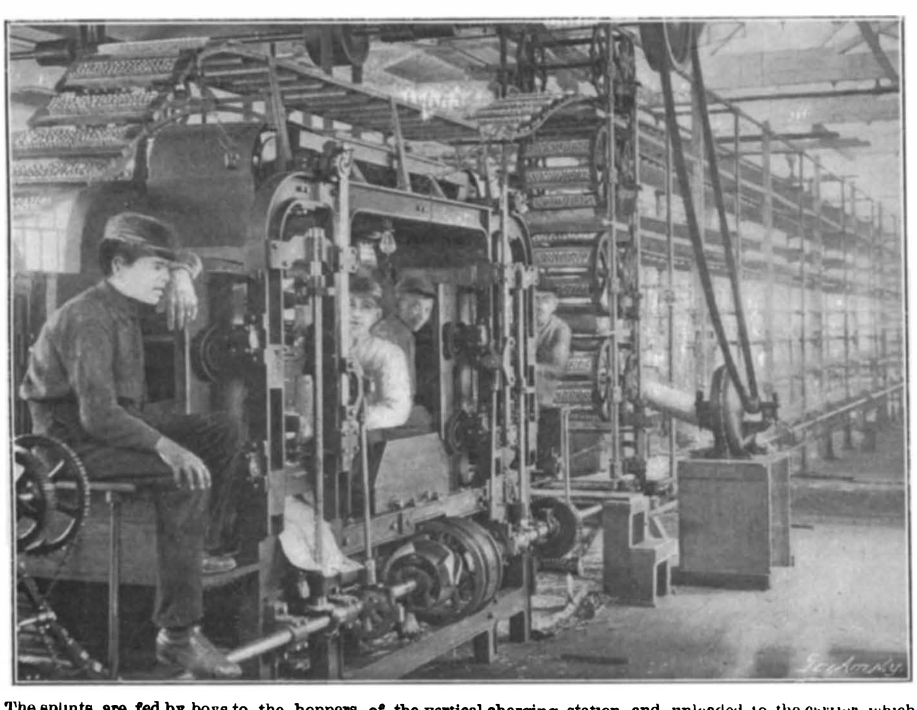
The matches are dipped by being drawn over the roller, which is partly immersed in the liquid phosphorus.

THE PHOSPHORUS BATH.

The Match-Making Machine.—The very interesting match-making machine shown in our illustration finishes the match in one continuous operation; dipping it in paraffine wax, tipping it with phosphorus, drying it out, and delivering it ready for shipment, the whole operation taking just 32 minutes, and the matches being turned out at the rate of 18,000,000 per day of 20 hours. Generally speaking, this machine may be described as an endless belt, 600 feet in length, known as the carrier, which extends up and down the length of the room, passing at each turn over end-sprockets. The belt travels with an intermittent motion at the rate of 9 inches a stroke and 30 strokes a minute. Each link of the belt consists of a set of transverse slats, known as a "block," and in each block are placed 400 splints. After the splints have been inserted no further handling is necessary, each block being successively dipped in wax, dried, tipped with phosphorus and again dried, and finally delivered as finished matches ready for packing.

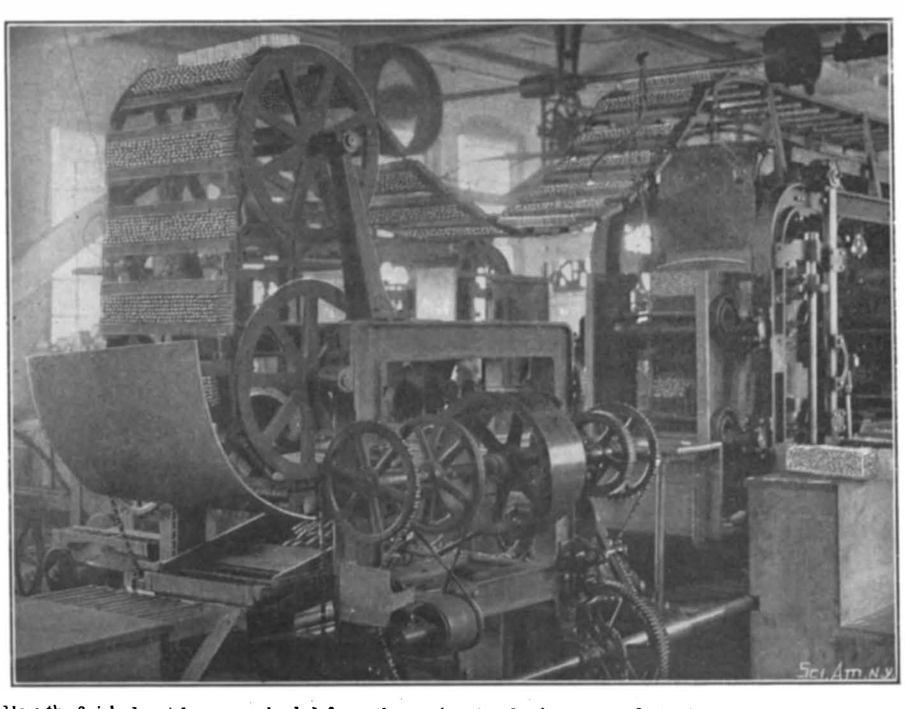
The special improvement in the machine under consideration, as distinguished from all others, lies in the great rapidity with which the splints can be charged into the endless carrier. In the ordinary type, the splints are fed a few at a time from a single hopper located at the charging station, a single row of matches being fed at each forward movement. In the machine herewith illustrated the hopper is replaced by a vertical loop, called the charging station, which is arranged above the endless carrier and has an intermittent motion corresponding in speed and frequency with the movements of the carrier. In the vertical sides of this charging station are eight assembling stations, each of which performs functions corresponding to those of the single hopper in the old type of match-making machine, by charging in this case a row of 50 splints into special perforated brass holders. Each of these holders has a capacity of 8 rows of splints; and by the time a holder has made the circuit of the eight charging stations and passed entirely around the loop, it is loaded with its full quota of 400 splints. The loaded holder is now automatically brought into position over the carrier, and its load discharged directly into the frame or "block" beneath it, 400 splints being delivered at each intermittent stroke of the machine. It will thus be seen that, by the provision of a separate multiple-unit charging station in place of the single hopper, the capacity has been increased 10-fold.

Each frame is made up of 9 parallel slats of wood, which extend across the full width of the carrier. As each frame is successively brought forward beneath the brass plates the load of 400 splints is pushed down from the plates into the frames. The slats are then closed up tightly, and the splints locked in, by means of a circular cam. The position of the matches will be seen clearly in the various illustrations. The endless carrier, as we have said, has an intermittent motion in one direction, and the insertion of the matches in the block is accomplished at the moment the carrier is stopped—the cam opening the frames, the matches being transferred from the brass holder, and the slats closed up and locked before the carrier makes its next advance. The frames, with the matches in place, next travel over a steam-heated drying table, at the end of which a beater strikes a blow upon each frame and levels the matches out evenly, ready for their passage over the phosphorus roller. The lower ends of the splints then travel through a bath of melted paraf-



The splints are fed by boys to the hoppers of the vertical charging station, and unloaded to the carrier, which passes beneath the station.

THE CHARGING STATION.



Here the finished matches are unloaded from the carrier after having traversed the full circuit of the machine.

THE DISCHARGING STATION.

fine wax, the paraffine being necessary to make the splint burn easily after the match is struck. The matches next travel over a roller, the lower part of which is immersed in a steam-heated bath of melted phosphorus. As each frame, with its 400 matches, travels across the upper portion of this roller the proper amount of phosphorus is deposited. By the time the matches have traveled in the carrier through the whole circuit of the machine the composition has become thoroughly dried out. The matches are ultimately brought back to the receiving station end of the system, where the circular cam descends between the slats and releases the matches, and they are pushed out of the carrier frame automatically by means of a discharger comb which descends from above the slats for this purpose. The matches are then carried down over an inclined, oscillating table, where they are automatically arranged in parallel piles for convenience of handling. They are then gathered up and taken to the packing tables, where they are put into match boxes of various sizes, and packed in boxes and in crates for shipment.

In closing, it may be mentioned that only 5 boys are required for operating this machine. This may be compared with the older match-making machines for which the services of 25 men were necessary.

Our Coal Exports.

Coal exportations from the United States during the fiscal year just ended, as shown by the Treasury Bureau of Statistics, amounted to $22,317,459, against $19,502,813 in the fiscal year 1900, $13,661,028 in 1899, $11,008,643 in 1897, $10,646,062 in 1896, and $8,391,026 in 1891. Thus the value of coal exportations from the United States has doubled since 1897 and nearly trebled in the decade. These figures relate to values. Measured by quantity the increase has been even greater, the exports in 1901 being 7,676,149 tons, against 2,399,039 tons in 1891, thus making the total exports of 1901 in quantity more than three times as much as in 1891.

The United States now stands third in the list of coal-exporting countries of the world. The coal-export figures of the principal countries of the world in 1899 show that while Belgium slightly exceeded the United States in the total number of tons exported, her imports were more than one-half as great as her exports, making her net exportation of coal much less than that of the United States. The figures of coal exports during 1900 recently published by the British government, a copy of which has just reached the Bureau of Statistics, show that the coal exports of the three principal coal-exporting countries—the United States, Germany, and the United Kingdom—in 1900 were: United States, 7,558,000 tons; Germany, 18,055,000 tons; and United Kingdom, 58,405,000. Thus, while the growth of the coal exports from the United States shows a large percentage of increase, these figures of the exportation of coal from Germany and the United Kingdom show that the field occupied by those countries is still much larger than that which the United States now supplies.

In growth of both exports and production, however, the United States had made much more rapid advance than any other country. The total quantity of coal produced in the United Kingdom was, in 1886, 157,518,000 tons; in 1900, 225,181,000 tons; while in the United States the production was, in 1886, 100,664,000, and in 1900, 245,422,000. Thus the United Kingdom since 1886 has increased her production but about 50 per cent, while the United States has increased hers nearly 150 per cent.

The cost of coal has meantime increased much more rapidly in the United Kingdom than in the United States. The value of the 157,000,000 tons of coal mined in the United Kingdom in 1886 is put by the statement of the British government above referred to at £38,000,000 sterling, and of the 225,000,000 tons mined in 1900, is put at £121,000,000 sterling. Thus, while the quantity mined in the United Kingdom has increased but 50 per cent from 1886 to 1900, the value has meantime increased over 200 per cent. On the other hand, the value of the 100,000,000 tons of coal mined in the United States in 1886 was, according to the same authority, £32,000,000 sterling, and that of the 245,000,000 tons mined in 1900, £67,000,000 sterling. Thus, in the United States, while the quantity increased about 150 per cent, the value of the coal mined increased but a little over 100 per cent.

The relative increase in the cost of coal in the United Kingdom and the United States is shown in an even more striking form in the statement of the British government above referred to by a table which gives the price per ton of coal in the United Kingdom and the United States in 1888 and 1900, respectively. It shows that the price in the United Kingdom advanced from 5 shillings per ton to 10s. 9d., from 1888 to 1900, while in the United States it fell from 6s. to 5s. 5½d. per ton in the same time. Another table in the same statement shows the relative value per ton of coal produced taken at the pit's mouth in the United States, United Kingdom, Germany, France, and Belgium, in 1899, to be as follows:

Country.	Value per ton. Shillings	Pence.
France	9	12
Belgium	9	11
Germany	7	9
United Kingdom	7	7
United States	4	8½

DISTRIBUTION OF COMBINED ELECTRICAL ENERGY.

BY ALTON D. ADAMS.

After electrical energy from scattered water powers and steam plants has been combined and reduced to a common voltage at a main switchboard it is ready to be transformed and converted for any desired purpose. Alternating lines to local transformers, that supply private consumers for 110-volt incandescent lamps, go directly from the main switchboard at about 2,000 volts. These same lines may feed other local transformers that deliver current at 500 volts for induction motors. Such motors are also often supplied by circuits from 500-volt transformers in the sub-station.

Other transformers in the sub-station, of the constant-current type, change constant pressure energy from the board to current at variable pressure for series alternating arcs. To supply direct current energy is drawn from the main switchboard by transformers, which in this case feed alternating motors or rotary converters. If series lines for direct-current arc lamps are to be operated, current from the transformers, at probably 500 volts, will drive alternating motors connected mechanically to the usual types of arc dynamos. A 220-volt, 3-wire, direct-current system is supplied from rotary converters of this pressure, fed by transformers connected with the main switchboard. Street railway and stationary motors requiring 500 volts, direct current, are supplied from still other rotary converters, driven by alternating current from transformers, fed as before. If storage batteries form a part of either the 220 or 500-volt direct system, they draw their charging energy from the same converters that supply the lamps and motors. A variation from the methods of direct-current production just outlined is sometimes made by the use of alternating motors to drive one or more lines of shafting, to which generators for the several sorts of direct current desired are mechanically connected. This plan is easily resorted to where a steam plant in the city served is necessary to supplement the combined water powers during a portion of the time. If the steam station has connected to its main shaft three-phase alternating generators, as well as the dynamos necessary for direct-current service, at times when the water power is sufficient to carry the entire load, these 3-phase generators may draw energy from the main alternating switchboard and, operating as motors, drive their connected shaft and with it the several direct-current dynamos.

Thus far only that sub-station where the energy from various water powers is received and combined has been mentioned, but there may be others. The pressure of about 2,000 volts, adopted for distribution from the main switchboard, is high enough to give a substantial advantage over the 220 and 500 volts necessary on some of the direct-current circuits, in the cost of conductors where a considerable distribution area is to be covered. For this reason minor sub-stations are established at convenient points in the area of distribution, each containing one or more transformers and rotary converters, yielding direct current at 220 or 500 volts, and also in some cases storage batteries, to increase the capacity at periods of maximum load and to steady the pressure. Other minor sub-stations may contain simply transformers, for series lines of alternating arc lamps, or for 500-volt alternating motors, all fed from the 2,000-volt switchboard at the combining sub-station. The methods employed to gather up the energy of scattered waterfalls, transmit it to a common center, combine it for general use, and distribute it over the area of urban service in the forms desired by consumers, have now been outlined. Example of actual accomplishment along these lines may not be uninteresting.

Among the cities of New England numerous instances may be found where the combination of energy from distant water powers for electrical distribution has been carried out to some extent, but two places, Manchester, N. H., and Hartford, Conn., present the most complete examples of the above methods.

At Manchester electrical energy from four separate water powers and two steam plants is received, transformed, combined and then distributed at a single sub-station. One of the water powers is 3 miles, one 6 miles, one 10 miles and one 14 miles from this sub-station. The larger steam plant is less than 200 feet from the sub-station, and the smaller one is three miles away, in the same building with the nearest water power plant. At this nearest water power the electric generators have a combined capacity of 1,090 kilowatts and are operated in varying proportions by steam and water, according to the amount of the latter available. Current is generated at 2,000 volts, alternating by these machines, and then raised by transformers to 6,600 volts for transmission to the sub-station. The water power six miles away drives a single alternator of 1,200 kilowatts capacity, at 10,000 volts, and this energy goes direct to the transmission line without the intervention of transformers. Ten miles from the sub-station the water power drives generators of 600 kilowatts total capacity, at 1,000 volts, and the current is raised to 10,000 volts for transmission. At the greatest of these water powers, 14 miles from the sub-station, the alternating generators now being installed have a combined output of 2,600 kilowatts at 12,000 volts, and are connected directly to the transmission line. The steam plant, close to the sub-station in Manchester, operates alternating generators having a total capacity of 1,250 kilowatts, and dynamos with a direct-current capacity of 1,300 kilowatts, from a single main shaft. These alternating generators, when steam-driven, deliver current at 2,000 volts to the main switchboard in the sub-station, where it is combined with energy from the other steam plant and the four water powers. The direct-current machines have their own distribution boards in the steam-generating station.

At times when the energy from water powers is sufficient the main shaft in the steam station just described is driven by the alternating machines acting as motors and drawing energy from the switchboard in the sub-station. This practice puts the entire load onto the water powers, and converts the steam-generating plant into a sub-station for direct-current distribution. All of the energy delivered at the switchboard in the sub-station is at 2,000 volts, 3-phase, suitable for general distribution to transformers on the premises of consumers for the operation of arc and incandescent lamps and motors. The plans here adopted for the combination of energy from distant water powers make it possible to distribute in the city of Manchester more than 5,400 kilowatts, or 7,200 horse power for direct and alternating electrical service from these sources alone.

At Hartford a separate department of the steam-driven station receives 2,700 kilowatts of electrical energy from two water powers, and there combines it with 2,500 kilowatts from local generators. The two water-power plants are distant, one between 10 and 11, the other between 11 and 12 miles from the Hartford station. At one water power are located generators of 1,200, and at the other of 1,500 kilowatts total capacity, in each case at 500 volts. Transformers are employed at both plants to raise the voltage to 10,000, at which it is delivered to the transmission line and received in the main station at Hartford. Transformers at this receiving station reduce the pressure to 2,400 volts and deliver the energy to the main switchboard. The local steam-driven generators also deliver alternating current at 2,400 volts to this same board in combination with that from the water powers for general use. In this same station other transformers reduce the pressure of a part of the alternating energy from 2,400 volts, for 220-volt rotary converters of 800 kilowatts total capacity, that feed a direct-current, 3-wire system of distribution. At the principal sub-stations, also in the city, but some distance from the steam station, are located other 220-volt rotary converters and their transformers, fed from the main 2,400-volt switchboard. These converters also supply the 3-wire system and charge a large storage battery in the same station, which is used to increase the rate of output and to steady the pressure. At the steam station, and also at two small sub-stations, are located constant-current transformers, which operate alternating arc lamps on series lines for street lighting. These last transformers are also fed by the 2,400-volt system. This system is 2-phase at 60 cycles, and in addition to the transformers for rotary converters and arc lamps supplies those for local incandescent service.

Depth of the Atmosphere Surrounding the Earth.

The Belgian Royal Meteorological Observatory has published the estimates made by various mathematicians and physicists regarding the depth of the atmosphere surrounding the earth. The calculations of the various savants upon this subject are widely divergent. Biot estimated that the depth was only about 40 miles; Bravais, 70 miles; Mann, 81 miles; Callandrau, 100 miles; Schiaparelli, 125 miles; Marie Davy, 187; while Ritter stated that it reached to a height of 216 miles. In Great Britain, during the early part of the last century, the depth of the atmosphere was generally accepted as being 47 miles, but the fact that meteors became incandescent at a much greater altitude incontrovertibly proved that this calculation was fallacious. Sir Robert Ball states that meteors have been observed at a celsitude of more than 200 miles, and since they only become incandescent when they come into contact with the air, the calculation of Ritter appears to be the most correct.

Science Notes.

The British Association meets in Glasgow September 11, and the session will last eight days. It will be followed by a geological tour in the Highlands.

An English clergyman named Bacon is making balloon ascents in and around London with a view to ascertaining the sources of London fog.

Farmers who live on the lines of rural free mail delivery routes are to have the advantage of the Weather Bureau's forecasts of the weather. Arrangements are being made by the Post Office Department and the Weather Bureau to have the mail carts equipped with signals, which will be displayed on the sides. The signals will be conspicuous, so that they can be read at a considerable distance from the highways.

Prof. Woodward, of the Natural History Museum, of South Kensington, London, who has been engaged for some time past in excavating at Pikermi, near Marathon, has recently completed his work. One of his most valuable discoveries is a collection of heads of horned horses. These were unearthed at Eubœ, where the professor carried out some experimental excavations for palæontological remains. In addition to the heads of the horned horses, the heads and shin bones of rhinoceri and other prehistoric animals were discovered. It is curious that out of the six places in the world where the remains of the horned horse have been found three are in Greece and a fourth in Samos, in the Greek Archipelago.

The United States Consular List furnishes some interesting information concerning the tenure of office of our diplomatic corps and consular service. Out of 276 persons employed in these services it appears that 190, or 69 per cent, have served for 5 years or more; that 37 per cent have served for 10 years or more, and that 14 per cent have served for 20 years or more. Three persons have served for 27 years each, two persons 28 years, and one person each 29, 30, 32, 37, and 48 years. The average term of service of persons in the United States Consular and Diplomatic Service abroad has been 9.4 years. From the above figures it would seem that the charge that our consular and diplomatic service is wanting in experience is scarcely sustained, says The National Geographic Magazine.

A novel method of teaching the French language by the phonograph is being attempted in England. Several prominent French professors are devoting their energies to preparing phonograph cylinders carrying French lessons upon them. The phonographic records are accompanied by a book, "The Pictorial French Course." Each book contains thirty lessons, each of which corresponds to a phonographic cylinder, and each lesson is ingeniously illustrated. All that the student has to do is to set the phonograph is motion, and the book will explain what the instrument is saying. The object of this system is to give the French accent correctly.

N. Passerini has carried out a series of experiments on a variety of different plants, from which he draws the conclusion that the parts of a plant exposed to the sun attain a temperature considerably higher than that of the atmosphere; while those not exposed to the direct rays usually exhibit, during the warmer part of the day, a temperature sensibly lower than that of the surrounding air. The greatest difference observed in the case of exposed parts was 17.2 deg. C. The side of fruits exposed to the sun absorbs the greatest amount of heat, and hence assumes a deeper color, and forms the largest amount of sugar. Fruits situated low down, near the ground, absorb most heat, since they receive that reflected from the soil as well as the direct rays. A portion of the heat absorbed directly from the rays of the sun is dispersed by radiation when the calorific rays cease to impinge on the plant; but the increase of potential energy does not proceed exclusively from the purely luminous rays.—Nuov. Giorn. Bot. Ital.

Messrs. Berson and Suehring, the famous meteorological aeronauts of the Berlin Observatory, accomplished a magnificent ballooning feat recently by attaining an altitude of 33,800 feet—almost 6½ miles. This is the greatest height recorded by the instruments carried by the aeronauts, but it is probable that they ascended to a greater altitude. The maximum height they attained, however, is unknown, since both the observers fainted owing to the rarefied atmosphere. The temperature last observed by them was 40 deg. of frost. Herr Berson ascended to 27,000 feet at the Crystal Palace a few years ago. The latest achievement is certainly notable in the annals of aeronautics, but it is not the highest altitude that has been attained by a balloonist. In September, 1862, Messrs. Glaisher and Coxwell ascended from Wolverhampton to a height of 36,000 or 37,000 feet. The exact altitude was not recorded, since the two men were overcome by the intense cold, and the rarefaction of the atmosphere. Mr. Glaisher fainted and Mr. Coxwell only just succeeded in opening the valve by pulling the valve-rope of the balloon with his teeth to enable the vessel to descend.

Engineering Notes.

It is asserted that the number of compound locomotives in use in this country (as compared with simple engines) averages 75 per cent of the whole number in use in freight and passenger traffic.

An English steamship company has issued a circular letter offering free passages to delegates from labor unions who wish to visit this country to ascertain the exact conditions of labor and wages here, and also what advantages, if any, we have in the way of labor-saving tools.

Very curious interpretations of the laws occur at times, so curious that it seems as though the officer in charge did not see his way very clearly to any reasonable settlement. A workman going up the gang-plank of a vessel in an English dock fell and hurt himself so badly that he died in a few days. The judge decided that his family was not entitled to compensation because a ship was not a factory; on appeal this decision was sustained by another court, but further appeal to the House of Lords resulted in a reversal of the verdict that a ship was not a factory. It was a factory to the plaintiff in the action, because that was where he was earning his living; the ship was in drydock and it was a factory, therefore the workman's family were entitled to recover.

A new railway of military strategic importance is contemplated in England, connecting the port of Southampton with the north and center of the country. Southampton is now the sixth port in Great Britain, and is utilized instead of Portsmouth as the embarkation port for the troops. At present, it is only served by one railway, and if connection is desired with the north of the country it is quicker to travel via London. This deficiency of railway communication would be seriously felt in the event of war, since, if the present railway were interrupted, Southampton would be completely isolated. It is therefore proposed to establish direct communication between the port and the military depots and manufacturing centers of England, so that in the event of hostilities men and stores could be quickly transported from the North to the Southern port.

Major Renard, the celebrated military aeronautical expert, has devised a new airship which it is claimed will be superior to that of M. Santos-Dumont. A new type of motor has been constructed by this engineer at the government works at Meudon, but so jealously has its construction been guarded, that no particulars regarding its design are known outside government circles. It is claimed, however, that the motor generates sufficient speed to enable the aerostat to be navigable in all weathers, save a gale. The preliminary experiments with the vessel will be carried out in October and November. They are to be of a very severe and exacting nature, in order to prove the possibilities of the propelling engine. One trial is to consist of a trip from Meudon to Rouen and back, a total distance of 170 miles. Major Renard is confident of accomplishing the journey without a single stoppage and at a fair rate of speed.

Owing to the great success that has attended the inauguration of the turbine passenger steamer "King Edward" on the Clyde, a fresh interest has been stimulated into this new method of marine propulsion. The "King Edward" is to be taken round to the English Channel and will ply for a short while between the various English and French pleasure resorts. If the turbines prove as successful on these routes the trans-channel packets will in all probability be constructed upon the turbine principle. When the Hon. C. A. Parsons, the inventor, delivered a lecture before the Institution of Engineers and Shipbuilders in Scotland upon the marine steam turbine and its application to fast vessels a short while ago he stated that he was particularly interested in its installation upon Atlantic liners, and summarized the advantages that would accrue from its inception, such as increased speed, due to reduced weight, economy of steam, absence of vibration and greater cabin accommodation.

The dangers of the process of storing petroleum in underground tanks were strongly exemplified in London recently. A firm in Hackney Wick had twenty-five of these underground tanks filled with petroleum. The system of discharging water through five separate intercepting chambers was conceded to thoroughly extract all but the smallest portion of the spirit. A heavy storm broke over the district during the afternoon, and the sewers failed to cope with the heavy rush of storm water. Consequently a large amount of water found its way to these tanks and washed away from three of them the puddling clay with which they were sealed. A large quantity of spirit was thus liberated. The storm was followed by a fire in the vicinity of the petroleum tanks, and while the firemen were engaged in its subjugation the petroleum flowing through the streets with the superfluous water exploded with terrific violence. Four people lost their lives and several were injured. Fortunately the concussion did not disturb the other tanks, otherwise an appalling catastrophe would have ensued.

Electrical Notes.

The Marconi station installed on the Nantucket lightship has proved to be very successful and several transatlantic steamers have been able to communicate successfully with the shore by its aid.

The Swedish government is considering plans for the substitution of electricity for steam on all the Swedish railroads, water power being so abundant that large economies would be effected.

The Rochester Railway Company will begin on October 1 to run a trolley car between various parts of the city and the theaters. A charge of 25 cents will be made for the car service, besides the cost of the theater tickets, to which the car coupon will be attached.

The principal electric railway company in Berlin will award two prizes of $750 and $375 each to the best and second best speed indicator for electric cars. The conditions which such a device must fulfill are numerous. The maximum speeds are to be indicated to the motorman by means of visible or audible signals. The device must be also so simple and durable that the jarring of the car will not affect its operation. The competition closed on September 1.

An experiment with electric traction for the towage of barges is to be made on the River Lea, in England. A pair of rails are to be laid down on the towpath of the river, upon which will run a small hauling trolley propelled by the overhead system. It is anticipated that by this means the transit of barges along the river will be considerably accelerated and cheapened. If this experiment proves successful, it is intended to establish a similar system of electric traction in connection with the various canals and waterways of the country. The traffic of goods by barges is very extensive in England, owing to the cost of transport being much lower than that of the railroad.

During the first six months of this year the Central London Electric Railway carried 20,385,739 passengers. of this total 2,190,000 were workmen who traveled the round journey of 13 miles for half fare—2 cents. The earning capacity of the line has been $4,750 per mile per week, and a dividend of 4 per cent was declared. The new electric trams which run from the Shepherd's Bush terminus of the railroad to the more distant suburbs has resulted in the conveyance of 5,000 additional passengers daily. The company now states that they have satisfactorily solved the vibration problem. Experiments have been carried out with a modified engine which so far has overcome the effects of vibration. The company also are experimenting with the idea of dividing the power so that the weight of the engine is distributed over the entire train, and the force of impact due to the weight of the engine on the rails is thus considerably decreased.

It is stated by The Engineer that the General Electric Company of Berlin has just completed near Naples, in the Valley of Pompeii, an installation for the transmission of electric energy, all the conductors used being of aluminium. This installation comprises three horizontal turbines of 150 horse power, working at 190 revolutions per minute. These turbines each drive a tri-phase alternator, and the current, at a tension of 3,600 volts, is led along three aluminium lines to Pompeii, Sarno and Torre Annunziata. The first of these lines, which has a length of about 3 kilometers, leads to a sub-station comprised of two three-phase transformers of 45 kilometers. The second line, which leads to Sarno, has a length of 15 kilometers; it conducts the current to a tri-phase motor working at 3,500 volts, and driving a continuous-current dynamo of 36 kilowatts capacity. This installation supplies a three-wire system at a tension of 240 volts. Finally, the line to Torre Annunziata has a length of 3.5 kilometers, the current serving for motive power in the maccaroni factories in the district.

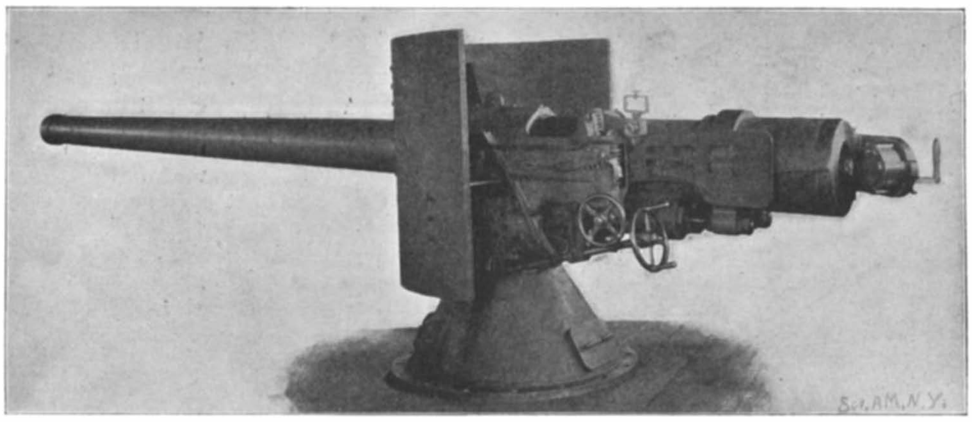
From a report in The Pall Mall Gazette it will be seen that the syntonic system of wireless telegraphy is not yet being used in His Majesty's navy: When "war" was declared Vice-Admiral Wilson very cleverly turned to account his thorough grasp of the new method of signaling. To the signal staff of his flagship he gave orders that they should not work their own wireless instruments, but should use these to read off the messages transmitted between the enemy's ships when the latter were near enough. . . . By thus using his wireless telegraphy instruments as ears instead of tongues, Vice-Admiral Wilson was enabled to gather a good deal of valuable information about his opponent. Sir Gerard Noel, the Commander-in-Chief of "B" fleet, it appears, adopted the ordinary naval code for his war signals, with the slight alteration that instead of making only three letters he made five, two of which were dropped when deciphering the message. It did not take the quick-witted signalmen of "X" fleet long to get the key to "B" fleet's code sufficiently to read all of its messages that were picked up by their instruments. Vice-Admiral Wilson took good care to issue for his own fleet a code that could not be deciphered by the fo

NEW 5-INCH SEGMENTAL WIRE-WOUND GUN FOR THE UNITED STATES ARMY.

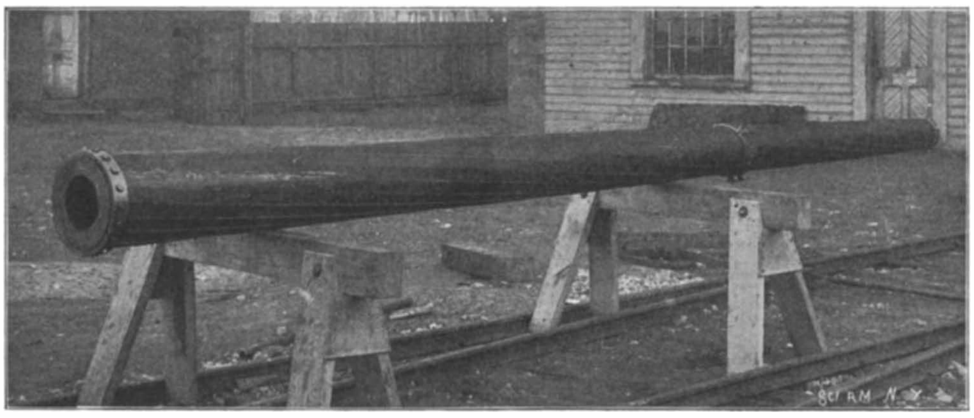
If one were asked to name the particular implement of war which is called upon to do the hardest work and endure the heaviest and most destructive stresses, he would not be very far wrong if he selected the modern breech-loading rifle. There is certainly no product of the forge and the machine-shop that is subjected to such extreme care, both in the selection of the raw materials and in the various details of its fabrication, as is bestowed on the high-powered rifle of to-day. Broadly speaking, the problem in gun manufacture is to secure the highest qualities of strength and endurance for a minimum weight of material. It is a well-known fact that the strength and lasting qualities of steel are directly proportional—other things being equal—to the amount of working to which it is subjected during manufacture; and, since the work that can be put into the steel is inversely proportional to its bulk, it follows that, in the manufacture of ordnance, the smaller the section of the elements of which the gun is built up, the greater will be the tensile and elastic qualities of the finished piece.

If the above proposition be true, it will be substantiated by the history of modern ordnance; and a brief review of the subject shows that with the increase in the strength of guns there has been an increase in the number of parts of which they were built up, and a decrease in the sectional area of these parts themselves. The cast-iron gun of the era of the Civil War was formed in one piece, and the best that it could do was to show a muzzle velocity of 1,500 feet per second. A single reinforcing hoop was then shrunk over the breech of the gun, and its effect was seen in an increase in the ratio of power to weight. This improvement opened up the way for the "built-up" guns which consist of a large number of separate elements, each of which is carefully worked, annealed and oil-tempered, in the effort to produce the highest possible results in elasticity and ultimate strength. Coupled with these qualities is the advantage that, in a gun consisting of many separate sections, the possibility of unseen flaws in the metal is reduced and the reliability of the piece is also proportionately increased.

In addition to these advantages, the metal in the finished built-up gun is thrown into a condition of initial strain which eminently prepares it for meeting the enormous stresses imposed at the moment of firing. The built-up gun consists of an inner tube, containing the bore with its rifling, and a number of superimposed hoops, which are turned to a carefully calculated diameter, less than that of the tube, and then enlarged by heating and shrunk on. The great tensile strain resulting from the shrinkage of the hoops throws the metal of the inner tube into a state of initial compression. The result of this is that the shock of discharge is felt throughout the whole body of the gun from bore to circumference, and every particle of the metal does its share of useful work. The system of built-up construction has undoubtedly been brought to a high stage of excellence, as shown by the fact that modern built-up guns secure a muzzle velocity of 3,000 feet per second with a maximum chamber pressure of 17 tons to the square inch.

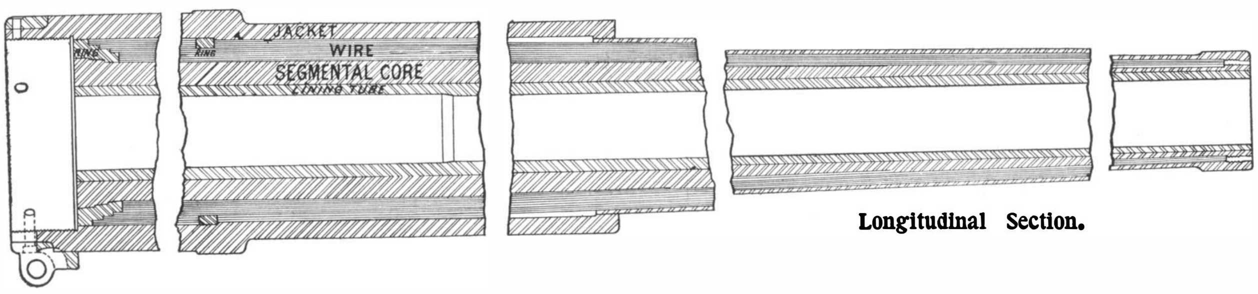


The Finished Gun on a Rapid-Fire-Pedestal Mount.



The Core of Involuted Sheets Assembled Ready for Winding.

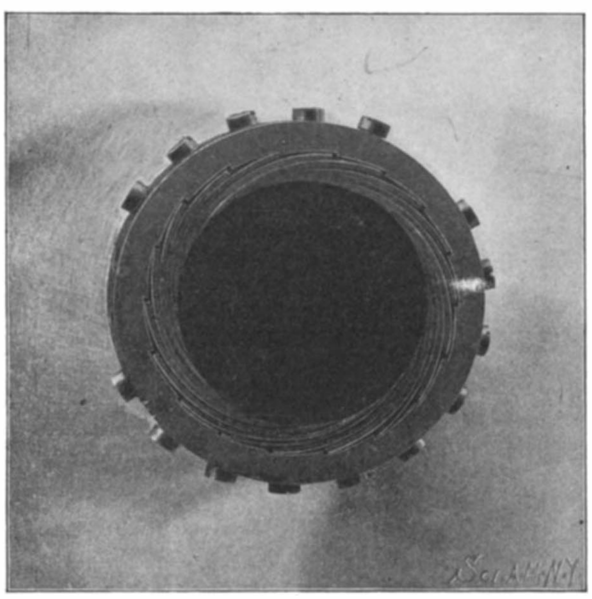
The method of securing the desired initial compression of the metal at the bore of the gun by shrinking on steel hoops is open to the objections that it is exceedingly expensive, the best guns costing a thousand dollars per ton weight of gun, and that it is not possible to determine with absolute certainty just how much initial strain exists in the gun after shrinkage. Moreover, in spite of the great care exercised in manufacturing the tube and hoops, these parts are sufficiently large to contain unsuspected defects which cannot be detected even by the most careful examination.



Longitudinal Section.

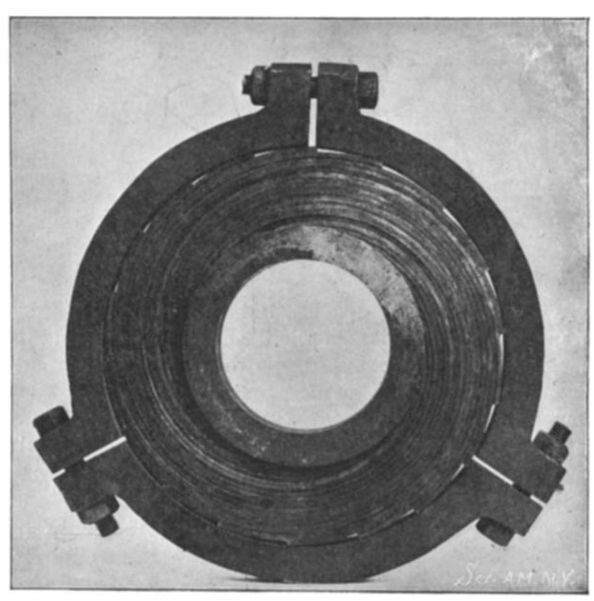
With a view to remedying these defects, the system of wire-wound gun construction was introduced, the credit for its inception being due to Mr. Longridge, in England, and the credit for its development and commercial introduction being due to the well-known Armstrong firm. In this system the gun consists of an inner tube about which is wound a ribbon of steel, the accumulated tension of the winding being calculated to produce the desired initial compression at the bore. Over the wire-winding is shrunk on a series of jackets as in the hooped gun. The system may be described as a compromise between the hooped gun and the fully developed wire-tube gun, which is represented by the piece which forms the subject of our accompanying illustrations.

In the Brown segmental wire-tube gun we have the highest possible development of the wire-wound system. Judged by the ballistic results achieved at the Government proving grounds, it is—weight for weight—by far the most efficient weapon in the world, and there is now under construction a 4½-inch gun, which, if it passes satisfactorily its proving test, will be so far in advance of any existing ordnance as to be positively in a class by itself. In the SCIENTIFIC AMERICAN for November 28, 1896, we published a description of the Brown system as applied in the 10-inch rifle which has lately been completed for the United States Government. The piece consists of a thin liner which forms the bore, a segmental tube wound with wire, and a jacket. The segmental tube consists of a large number of thin, tapered plates of steel which are assembled and clamped together, and are then wound with wire under a constant tension. The assembled segments form a kind of arch to sustain the accumulated compressive effect of the winding; and, owing to the fact that they are cold-rolled to their finished size, it is possible to secure in them a far higher quality, both as to homogeneity and compressive strength, than is possible in the inner or A-tube of an ordinary built-up gun. The cheapness of manufacture, furthermore, enables them to be produced at a cost below that of the tube. This 10-inch gun was planned in the early days of smokeless powder, and was designed for powder containing 66 2-3 per cent per cent of nitroglycerine. In its recent Government test, when it was fired with a 35 per cent nitroglycerine powder, it was found that the chamber was not large enough to contain as much of the new explosive as was necessary to give a muzzle velocity of 2,800 feet per second. The chamber has now been en-



View at Muzzle Showing Curved Sheets in Assembling Ring Before Liner is Inserted.

Group of Involuted Steel Sheets.



Section Through Sheet-Steel Tube, Showing Liner and Assembling Clamp.

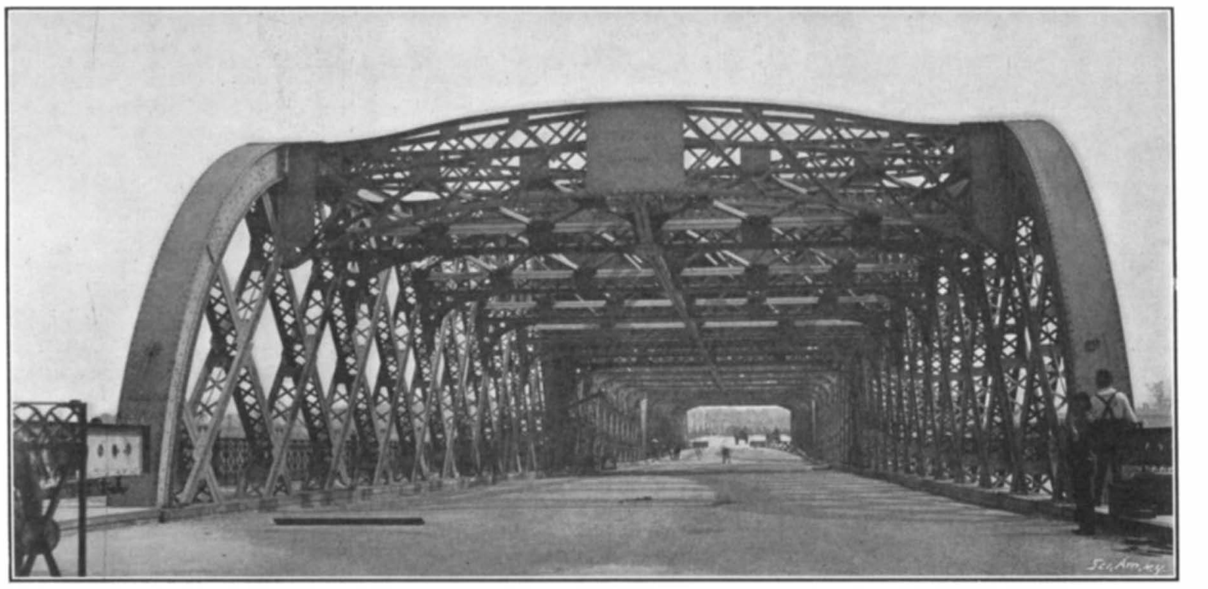
NEW 5-INCH, SEGMENTAL, WIRE-TUBE GUN FOR THE UNITED STATES ARMY.

larged to the required dimensions, and, judging from the results already achieved, when the gun gave its 575-pound shell a velocity of 2,503 feet per second, it is fully expected that the desired velocity of 2,800 feet per second will be obtained. The piece will then equal in velocity the navy 10-inch gun; but, as the shell fired from the Brown gun is 75 pounds heavier than the navy shell, and of the two guns the Brown is 7.4 tons lighter, the resultant muzzle energy and the foot tons of muzzle energy per ton weight of gun will be considerably greater, as is evident from the table below:

	Length in Feet.	Weight in Tons.	Weight of Shell in Pounds.	Muzzle Energy in Foot Tons.	Foot Tons of Energy per Ton Weight of Gun.
Brown Segmental Wire-Tube Gun............	37½	26.0	575	31,298	1,204
Navy Gun................	37½	33.4	500	27,216	815

The above table tells its own story, and to anyone who has followed the development of modern ordnance and is familiar with the best that has been done, it will be seen that the development of 1,204 foot tons of energy per ton weight of gun has never been approached, the nearest to it being that of the Krupp 50-caliber 12-inch gun which develops 946 foot tons per ton weight of gun.

Since the design of the first 5-inch gun was brought out, Mr. Brown has developed an important improvement by substituting for the straight segments as used in that gun a series of overlaid curved steel plates, as shown in our illustrations. The plates are formed from sheet steel, varying in thickness from 1.7 to 0.4 inches, which is cut to the desired taper, and rolled in a special mill to the involute form shown in one of the accompanying illustrations. The substitution of these involutes for the longitudinal segments is a logical step along the line of development which is being carried out so successfully in this gun. The substitution of straight segments for the inner tube of the accepted type of gun was made, as we have seen, with a view to securing more thorough working and higher quality in the steel. The thinness of the curved sheets, and the thorough working and subsequent inspection to which they are subjected, insure a yet more perfect condition of the core.



LOOKING NORTH THROUGH THE SWING-SPAN OF THE NEW BRIDGE.

Clear width of roadway, 42 feet.

The following description of the process of manufacture applies to a 5-inch gun which was built as a type piece and subjected to trials at Sandy Hook. The report of these firing trials, as made by the officer in charge, certainly does not betray any partiality for the gun, and therefore, particular value attaches to the fact that the results of the trials, as gathered from the report, prove that the gun has not merely achieved, but has considerably exceeded, the contract requirements. Unfortunately, it was mounted upon a carriage designed for guns of far less power, and it was impossible to carry the velocity to as high a figure as the gun was capable of securing, owing to the risk of injuring the carriage. The insufficiency of the carriage was foreseen and inevitable, and it in no way reflects upon the capabilities of the piece. In the construction of the segmental core, sheets of steel one-seventh of an inch thick, 30 inches wide and 19 feet long are cut into two pieces along a diagonal line, the resulting halves being each 24 inches wide on one end, 6 inches on the other, and 19 feet in length. One edge of the plates is planed to a curved bevel fitting the curvature of the outside of the lining tube, and each piece is bent in special rollers to the involute form shown in the accompanying illustration. Eighteen of these curved plates are superimposed on each other and assembled into the annular circular form shown in the illustration. They then are fastened by screw-bolts to two rings, one at the breech, and the other at the muzzle. Then more clamps are applied to the assembled segments, and a tapered lining-tube, rough-bored to 4 inches internal diameter, is forced by hydraulic pressure into the segments. More clamps are then added, one at every 4 inches of length. The lining-tube is then pressed home to its final position under a hydraulic pressure of about 50,000 tons. The structure is placed in a lathe and the outside of the segments is turned to a cylinder stepped with shallow shoulders at eight different points. The structure is then placed in another lathe, fitted with a gear for winding on the wire at a specified tension of 2,600 pounds per wire, or about 128,000 pounds per square inch. The end of the first wire is fastened by a plug into a hole in the first shoulder and is wound from there to the breech and back again to the shoulder, where it is fastened by plugging. The same process is repeated at each shoulder, the winding being carried to the breech ring and back to the shoulder from which it started. After the desired number of windings have been put on, the chase jacket is forced on with hydraulic pressure and a threaded muzzle cap is screwed into place. The trunnion jacket is then shrunk on, the liner is bored and rifled, and the breech mechanism fitted, leaving the gun ready for mounting.

We have before us a report by Prof. J. B. Denton, of Stevens Institute of Technology, of a mathematical analysis of the stresses of the 5-inch gun. From the summarized conclusions we quote the following:

"I. By means of the tension due to the wire windings all parts of the segmental core or tube will be bound together with sufficient pressure to cause the frictional adhesion between its curved lines of division to exceed the shearing forces which would be transmitted along these lines in a forged tube of the same thickness, when fired with powder developing the highest current pressures.

"II. The metal of the segmental core, by virtue of the magnitude of its frictional adhesion, is as available as a source of longitudinal strength and transverse stiffness as the same thickness of solid steel.

"III. The division of the core into parts gives it an advantage over the same thickness of solid metal, in that a crack or incipient rupture at any point will not depreciate its usefulness; whereas a flaw in the solid metal may induce rupture.

"IV. The distribution of the wire windings secures a practically uniform compressive resistance in the firing tube, throughout its length, and without exceeding 90 per cent of the elastic strength of the tightest wire, the lining tube was probably compressed so that, with 50,000 pounds per square inch of powder pressure, it was not required to exert a tensile resistance."

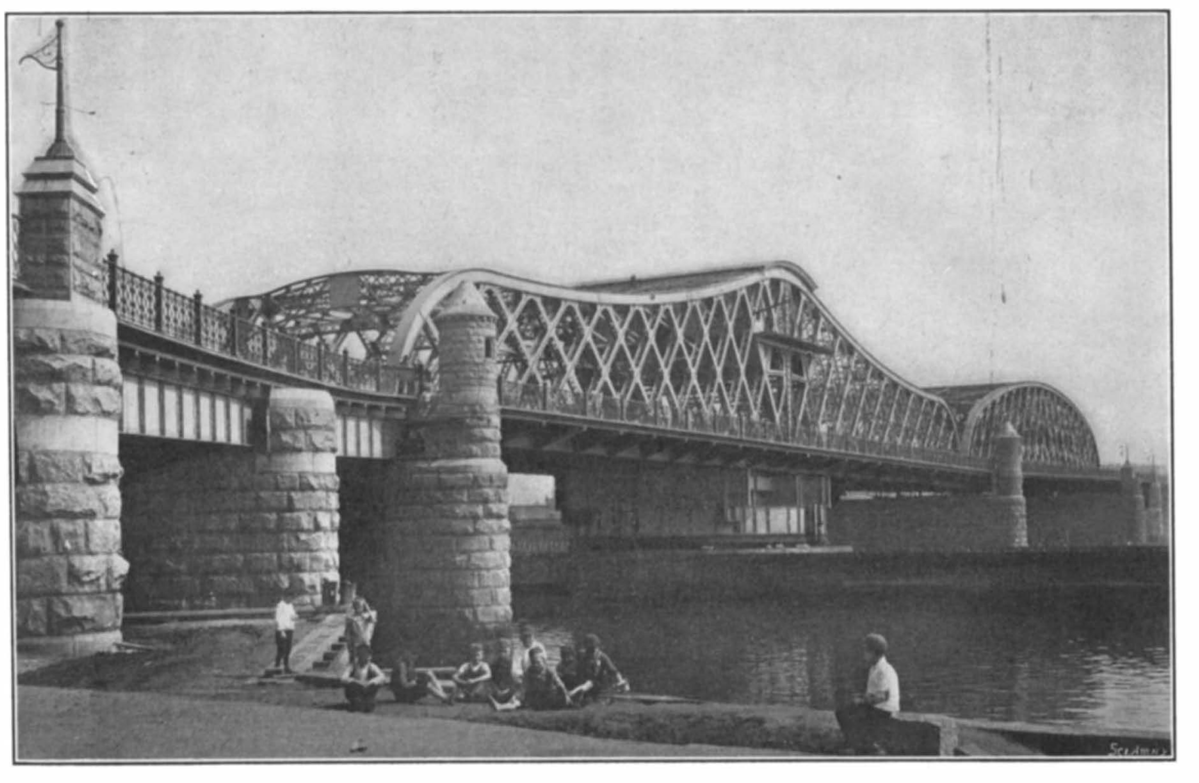
With this testimony of Prof. Denton to the longitudinal and tangential strength of the assembled "segmental core" before us, it is interesting to note that the cost of the segmental tube would be materially reduced. Moreover, to the above undoubted advantages is to be added another of scarcely less importance, namely, that whereas the manufacture of hooped guns can be carried out at only four establishments in this country, the manufacture of this type of gun is so simple that it could be carried on in any machine-shop where there is a crane to handle it and a lathe of sufficient length to turn it; which means that there are at least a half-hundred shops in the United States that could safely contract for the construction of a number of these weapons.

THE WILLIS AVENUE BRIDGE OVER THE HARLEM RIVER.

The opening of the handsome bridge which has just been completed across the Harlem River at Willis Avenue forms another important link between Manhattan Island and the suburban districts to the north of it. The new structure was commenced about three years ago, but its completion has been delayed beyond the time originally intended.

Although the length of the river-crossing is inconsiderable compared with the great structures which are being built across the East River, the overall length of the Willis Avenue Bridge entitles it to rank among the notable city bridges of the world. Its total length overall is 2,507 feet, and its total width overall, from railing to railing of the sidewalks, is 70 feet; while 6,200 tons of steel was used in its construction.

Commencing at the southern entrance at 125th Street, the bridge consists first of a masonry approach 345 feet in length. This is followed by 259 feet of short, plate-girder spans, carried on masonry piers, the last of these spans resting upon the fixed pier of the central swing-span. The latter is 310 feet in length between end pins, and provides two clear channel openings each of 108 feet width. To the north of the swing-span is a bowstring truss, 250 feet in length between end pins. To the north of this truss are six plate-girder spans, of a total length of 113 feet, followed by nine similar spans covering a length of 479 feet. The street grade is finally reached by means of a 200-foot masonry approach.



THE NEW WILLIS AVENUE BRIDGE OVER THE HARLEM RIVER.

Swing-span, 310 feet; fixed span, 250 feet; total length, including approaches, 2,507 feet.

The most notable feature of the bridge is the swing-span and the adjacent bowstring truss. Both are constructed on the riveted system, the top and bottom chords consisting of built-up box sections, the web members being built-up latticed struts and ties. The swing-span is similar in contour to the swing-span of the Third Avenue Bridge over the same river, which was opened a few years ago. An endeavor has been made to secure gracefulness of out-line by substituting curved lines for the straight lines with which we are familiar in the typical pin-connected truss-bridge, and the attempt has certainly been successful. The draw-span measures 46 feet from center to center of the trusses, which are 48 feet in depth between the centers of the chords at the deepest part of the truss over the center pier.

A clear roadway of 42 feet is provided, and the effect, as seen in the accompanying photograph, is certainly spacious and imposing. The sidewalks are 9 feet in width. They are carried on cantilever trusses which are riveted to, and extend at right angles from, the bottom chords of the trusses. The floor of the bridge consists of transverse floor beams which extend from truss to truss, with longitudinal stringers riveted between them, the whole being covered over with buckle-plates on which is laid a concrete and asphalt roadway.

The extensive sub-aqueous foundations called for 33,600 cubic yards of concrete and masonry below the water-line, and in the piers and abutments, above water, there are 23,800 cubic yards of masonry. The total cost of the structure was $1,500,000.

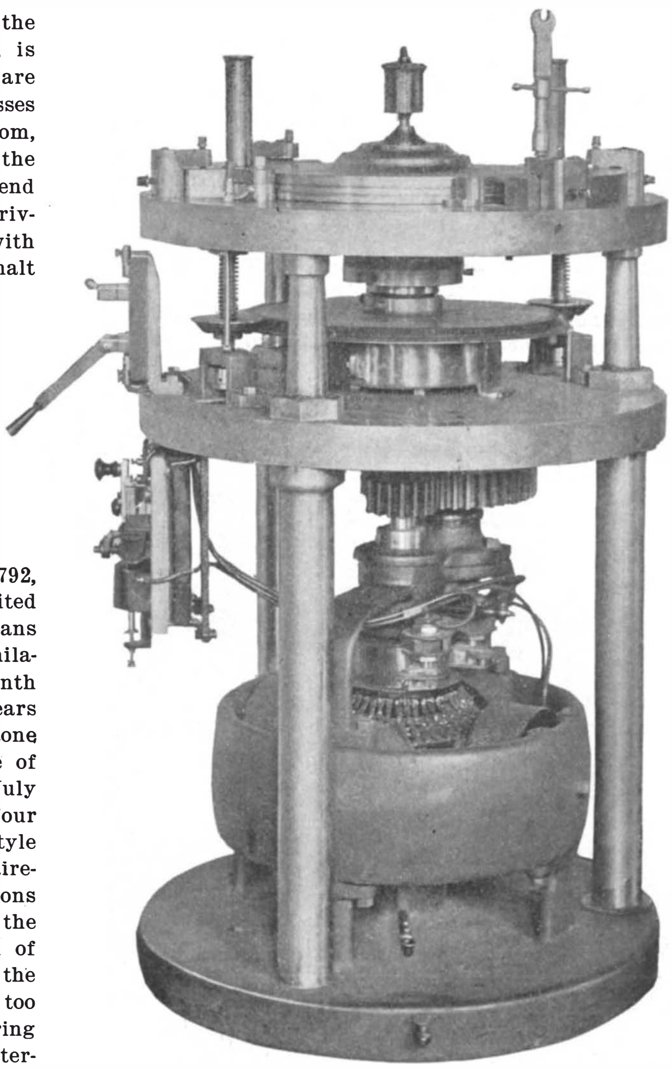
HOW MONEY IS MADE.*

BY MARCUS BENJAMIN, PH.D.

The Mint in Philadelphia was established in 1792, and is the parent institution of its kind in the United States, the other coining mints being in New Orleans and San Francisco. The first mint building in Philadelphia was erected on the east side of Seventh Street above Market Street, but before many years it was found too small for use, and the cornerstone of the second edifice, which is on the north side of Chestnut Street below Broad Street, was laid on July 4, 1829, but it was not ready for occupancy until four years later. It is of marble and in the Grecian style of architecture. In 1854 the building was made entirely fireproof, and since then numerous alterations have been made in the interior to comply with the requirements of the times. But with the growth of the country and the increasing demands upon the mint for coinage, the building has again grown too small, and a new mint has been erected on Spring Garden Street, near Seventeenth Street. Many interesting memories are associated with the old structure, and it would be pleasant to recall the work of the distinguished men who have been connected with it, such as James C. Booth, the melter and refiner, who was succeeded by D. K. Tuttle; Jacob B. Eckfeldt, assayer, and William Barber, engraver, who was succeeded by Charles E. Barber. Of these Messrs. Barber and Tuttle are still in the service. There is only space to mention one among the interesting rules, which required that provision should be made "for the care and feeding of watch-dogs," but it illustrates the primitive methods by which the Mint was cared for in early times.

The process by which the ore from the mine is changed into the new and glittering coin is long and tedious, but a brief summary of the principal steps may be of some interest. The ore as it comes from the ground must first pass through the smelting process, by means of which the metal is extracted and converted into bars of gold or silver, the methods naturally varying, according to the character of the ore and the locality.

Some idea of the enormous amounts that have been handled by the various mints and assay offices is shown by the statement that $2,996,763,252.27 represents the total amount of coinage of the various mints of the United States from the establishment of the Philadelphia Mint to the end of June, 1900. Of this great amount the total gold coinage was $2,167,088,113, the total silver, $796,171,159.55, and the total minor coinage amounted to $33,503,969.72. The bars of gold or silver, known as "bullion," are carefully assayed, either at the Mint or at one of the assay offices in New York city, Helena, Mont., or Denver, Colo.,† and from these the coins are made. The first step consists in preparing an alloy for coinage of the refined gold or silver, which is nearly pure, with copper, and this is accomplished by weighing out quantities of gold and copper, or silver and copper, which are then melted together in a large black-lead crucible; and after the molten metals are thoroughly mixed they are poured into cast-iron molds to produce rectangular bars called "ingots," which vary in size according to the denomination of the coin for which they are intended. Thus,



UPSETTING MACHINE—USUALLY CALLED A "MILLING" MACHINE.

the ingot for the "double eagle" is 12⅝ inches long, ½ inch thick, and 1½ inches wide, and weighs 80 ounces, while the ingot for the silver dollar is 12½ inches long, ½ inch thick, and 1⅝ inches wide. The ingot is then passed between heavy rolls from which it issues in long narrow strips. This operation is called "breaking down," and makes the metal hard and springy, and if continued would cause it to crack and split. In order to prevent this the strips are annealed by being heated in a furnace to about 1,500 deg. F., where they remain for about an hour and a half,

THE NEW MINT, SPRING GARDEN STREET, PHILADELPHIA.

according to the heat of the furnace and the size of the strips. They are then cooled in water and each strip wiped dry, after which they are finally passed through the rolls. "Double eagles" and "eagles" pass through the finishing rolls three times, while "half" and "quarter eagles" must go through at least four times. The strips are again annealed, cut in two for convenience in handling, taken to the pointing rolls so that an inch and a half of the end may be pointed or flattened, and greased with tallow to permit their easy passage through the dies of the drawbench. The drawbench consists of two independent sections, each of which has two dies regulated by set-screws, and between these dies the pointed end of the strip is passed, being seized by the jaws of the carriage, drawn by means of an endless chain, which reduces the strip as nearly as possible to standard weight. This is ascertained by weighing sample blanks or planchets that are cut from either end. When the strips are deemed of proper weight they are taken to the cutting shears and the pointed ends cut off, after which they pass to the cutting press, where, by means of a steel punch working into a matrix, the planchets are cut therefrom. These blanks are then taken to the washing-room, where they are cleansed from grease by washing in a lye composed of soap, borax, and water. After rinsing in clean water they are dried in a large copper pan heated by steam. They are then carefully examined on the selecting table and all perfect blanks separated from the imperfect ones, and, in the case of gold coins, must have the following weights: "Double eagle," 516 grains; "eagle," 258 grains; "half eagle," 129 grains; and "quarter eagle," 64.5 grains, although an allowance of half a grain is permitted in the case of the "double eagle" and "eagle," and a quarter grain in the "half" and "quarter eagle." This weight is determined in the adjusting room, where each piece is placed upon the balance, and, if heavier than the limit, is reduced by filing its edge, whereas if lighter it is condemned and returned to the melter. The accepted planchets are then taken to the milling machine where the raised edge, technically called "milling," is put on them.

The machines known as milling machines are simply upsetting devices, and the former designation often misleads one not familiar with minting processes. We illustrate the latest type, which has just been installed. Its duty is to upset the blank after it leaves the cutting press by passing the piece between a segment and a revolving disk, shown at the extreme upper left-hand corner, just below the feed tube. Grooves are cut in the disk and segment by a sharp tool, and the shape of the grooves has been the subject of considerable experiment in order to give as square an edge as possible to the finished coin without producing a fin. It is driven by a 3 horse power compound-wound motor running at 375 revolutions per minute, and transmits a rotary movement to the disk through back-gears. The disk runs at 60 revolutions per minute. The blanks are fed by the operator into the tube and are pushed against the disk by a small feeder, and the friction on the disk carries the blank around the inside of the segment and then it drops into a box. This upsetting machine will upset 575 half-dollars per minute, and the machines for other denominations will turn out a proportional amount. Nine of these machines, excepting the motor, were designed and built at the U. S. Mint, and it is the intention of the authorities to gradually work into the designing and building of several special machines for coining operations.

The advantage of the milling process is that it protects the surface of the coin from abrasion. The milled pieces must be again cleaned and softened, which is accomplished by annealing them at a cherry-red heat, after which they are dipped into a solution of sulphuric acid and water sufficiently strong to clean and brighten them. They are then rinsed in boiling water and shaken in sawdust to dry them, after which they are ready for the stamping press. Before stamping a brief description of the die is necessary. The design being selected, a drawing is made the exact size of the coin required, and from this drawing a tracing is taken for the purpose of transferring the design to the die. This is accomplished by covering the surface of the die, which has previously been made smooth, with a thin coating of transfer-wax; on this wax the tracing is reproduced by rubbing, leaving the design on the steel, and as this is easily obliterated it is best to go over the lines with a sharp-pointed instrument. The next step is to remove the steel in the die by means of chisels and gravers, so that a relief may be had on the coin. From time to time, as the work progresses, proof impressions are taken until the desired result is obtained. The die is then hardened, after which it is ready for use in the press. These dies are then adjusted in the stamping presses and the blanks fed to

*For the information contained in this article the writer is greatly indebted to the courtesy of the Hon. George E. Roberts, Director of the Mint.

†The assaying process is briefly described in an article by the present writer on "The Methods Employed by the Assay Commission" that appeared in the SCIENTIFIC AMERICAN for May 19, 1900.

the press through a vertical tube, and as each piece reaches the bottom of the tube steel feeders carry it over between the dies and place it in a steel collar, so that when the dies close upon the planchets it will make the obverse and reverse impressions on the coin. According to a description of the process in the Philadelphia Mint it is said that "double eagles" and "eagles" may be struck at an average rate of 80 a minute, while for the "half" and "quarter eagles" the average rate is 20 per cent greater. The pressure required in the stamping press to produce a sharp, clear impression of the "double eagle" is said to be 175 tons, while only 120 tons are required for the "eagle," 75 tons for the "half eagle," and 40 tons for the "quarter eagle." The silver dollar, half dollar, and quarter dollar are struck at the same average rate as the "double eagle" and "eagle," while the speed for the dimes is equivalent to that of the smaller gold coins. The pressure used in stamping the silver coins is 150 tons for the dollar, 110 tons for the half dollar, 80 tons for the quarter dollar, and 40 tons for the dime. From the stamping press the coins pass to the counting room, where they are put up in proper quantities for distribution. All coins but cents are counted in the usual way, the latter, however, are counted by means of a kind of screen. There are 1,000 depressions in it the exact size of a cent. The coins are brought from the machines in pails and a quantity are thrown upon the counting-screen, which is shaken until each of the depressions is filled. The cents are then tied up in coin sacks. In this very brief summary of the process by which the coin passes from the bullion to the finished money many of the important details have necessarily been omitted, but if there is any one thing more than another that is of conspicuous interest in the mints and assay offices of the government, it is the fact that nothing is lost. Every bit of metal is carefully accounted for, and defective blanks are promptly returned to the melter. Every kind of waste material that is likely to contain gold is preserved. The floor of the melting room is swept each day, and the gatherings are mixed with a suitable flux and thrown into a crucible. "Sweeps" consisting of broken crucibles and dipping cups, all ashes from the fires, burned gloves, aprons, sawdust, and packages in which bullion has been sent to the mint, settlings in catch wells and roof gutters are carefully preserved. It is reported that sales of such "sweeps" at the Philadelphia Mint have yielded a return as high as from $18,000 to $20,000 a year from the melting department alone.

THE WRECK OF THE SANTOS-DUMONT BALLOON.

All those who are interested in aerial navigation must welcome the news that M. Santos-Dumont is constructing a new balloon which will be ready early in September. It will have the same cubical capacity as the one which came to grief on August 8, but instead of being cylindrical, it will be ellipsoidal in shape, and the small interior balloon used for giving a greater or lesser inflation, instead of being at one end, will be placed in the middle. The illustrations which have come to hand of the unfortunate accident to Santos-Dumont's balloon on August 8 are very interesting, and they show how near he came to being seriously injured. On the morning in question he left St. Cloud at 6:12 and reached the Eiffel Tower in nine minutes. When halfway back, about fifteen minutes after he started, he noticed that the front of the balloon was collapsing, which seemed to indicate that gas was escaping. He at once attempted to drive air into the small balloon, or balloonet as it is called, but the motor refused to act. When the gas left the rear of the balloon, the silk hung in flabby folds which threatened to catch the screw. M. Santos-Dumont was afraid of an explosion, which would inevitably be followed by a fall, so he stopped the motor, and the balloon was at the mercy of the wind. It drifted about for a time and finally, after striking the chimney, went down between two sections of the Exposition Trocadero Hotel, where it hung suspended, as shown in our engraving, which is reproduced from l'Illustration.

The balloon lay at an angle of 60 degrees, the screw resting on the roof of one of the lower pavilions of the hotel. M. Santos-Dumont climbed up to the roof by means of a rope which was lowered to him and escaped without injury. When the firemen arrived he helped direct the salvage operations. He first ascertained that the motor had not been damaged. Ropes were then fixed to the framework and the balloon was finally lowered to the yard. The aeronaut at once announced his intention of building another airship to compete for the Deutsch prize, the competition closing for the year on September 15. If the prize is not won within five years, beginning April 15, 1900, the offer of M. Deutsch will become void. Until someone succeeds in gaining the prize M. Deutsch will turn over to the committee of the Aero Club the sum of 4,000 francs each year for distribution among those most deserving of encouragement.

THE WRECK OF THE SANTOS-DUMONT No. 5.

The Ruby.

In trade three classes of rubies are distinguished—rubies of the Orient, rubies of Siam, and spinel rubies.

The different varieties called balass rubies, Brazil rubies, rose rubies, rubace rubies, rock rubies, Siberian rubies, etc., cannot be compared at all with the preceding, of which they have neither the composition nor the constitution. Apart from the balass ruby, which from a scientific view-point does not differ from the spinel ruby, all the others are, properly speaking, only colored quartz or feldspar. The ruby of the Orient is the first of all colored stones in beauty, as in price. Its marvelous hue is that of the human blood, as it jets from an open artery, that of the red ray of the solar spectrum at its maximum intensity.

The ruby is one of the most exquisite products of nature, but it is becoming rare and more rare to find it perfect. It even causes atonishment to find an Oriental ruby as large in size as the topazes and sapphires of the same countries. If it reaches a certain size it is almost always filled with defects.

Rubies of all sizes are put to use. The smallest, down to 20 or 30 to the carat, are employed specially for delicate jewels, for numbers, figures, etc., Many of the smallest are cabochons. When a ruby exceeds the weight of a carat it commands a high price. A ruby may fetch ten or twenty times the price of a diamond of the same weight if it is really of a superior quality.

It may be interesting to give the figures at which rubies were valued fifty years ago. They were much lower than to-day. A perfect ruby of one carat was priced at 240 francs; of two carats, 960 francs; three carats, 3,600 francs; five carats, 14,400 francs; and six carats, 24,000 francs.

In general the cutting as a brilliant is alone suitable for a fine ruby. The ruby is very hard, almost as high as the sapphire. It was but little used for engraving in ancient times, doubtless because of the difficulty of finding those offering a sufficient surface, a reason more plausible than the explanation that the wax adhered to seals made with this substance. The two engraved rubies seen at the Mineralogical Museum of the Garden of Plants prove that successful work of this kind is well nigh impossible.

The carbuncle, to which the ancients attributed fantastic properties, was no other than the ruby. It served, as is said, to give light to certain large serpents or dragons whose sight had been enfeebled by age; they bore them constantly between their teeth, and laid them down only for eating and drinking. It is even claimed that the carbuncle emitted light in darkness, and that the thickest clothing could not stop its rays. Without all the exaggeration of such legends, it was believed for a long time that rubies contained luminous rays. The truth is that they have double refraction and send out the red rays with unequaled brilliancy. Traversed in a vacuum by an electric current they are illuminated with a red fire of extreme intensity. The greatest heat does not change their form or their color.

The most beautiful rubies come from Ceylon, India and China. The mines of Pegu are nearly exhausted, or but little worked to-day. The regions where they are situated are dangerous of approach; besides, in the states of the Grand Mogul the exportation of rubies is forbidden until they have been exhibited to the sovereign, who retains the most beautiful. The stone known under the name of the ruby of Siam is distinguished by its deep red color, somewhat resembling the garnet. But there is no need of being a connoisseur to note the difference between the ruby of Siam and the garnet.

The spinel ruby is much less rich in color, and contrasts visibly in tone with the other kinds. It is of a bright, poppy red. It is much less rare, especially of large sizes, and is not so hard. It is found in the same countries, in the midst of deposits of alluvium in the beds of the torrents. The finest come from Pegu and Cambay. The balass is a very inferior quality of the spinel, of which the color approaches a wine red or clear violet. It is cut with facility, but much skill is required for its polish. It is generally of little value, though large sums are paid for some balass rubies. A beautiful specimen belonging to the treasury of the crown cost 10,000 livres.

The large rubies of the Orient, being excessively rare, are so much the more celebrated. The largest known in Europe is said to be the one that the Russian caravans brought from China with other precious stones in exchange for their peltries, and which forms today one of the rarest ornaments of the Imperial Court of Russia. The one of which Chardin speaks with admiration was a cabochon, was of splendid color, and bore engraved the name of the sheik Lephy. That of the King of Persia, of which Tavernier made a drawing, weighed 175 carats. That of the King of Visapour, a cabochon, fetched in 1653 near 75,000 francs. The one possessed by Gustavus Adolphus was as large as a small egg, and of the most beautiful water. It was presented to the Czarina on the occasion of his visit to St. Petersburg in 1677.

It is seen by the inventory of 1791 that France possessed 81 Oriental rubies, of diverse forms and qualities. One of them remained for a long time in a rough state, in consequence of two or three points which could not be removed without sensibly diminishing the value of the stone; but a diamond artist was able to put these defects to use and transformed the rough stone to a dragon with outstretched wings. This is the most beautiful Oriental ruby known.—Le Diamant.

The Current Supplement.

The current SUPPLEMENT, No. 1340, is begun by a most interesting article upon "The Temples of Nikko," accompanied by six engravings. "Fossils and Their Teachings" is a lecture by Prof. Angelo Heilprin. "St. Paul's" gives a report of the official architect relative to the condition of the celebrated cathedral. "Smyrna Fig Culture in the United States" is by Dr. L. O. Howard, and is accompanied by a number of illustrations. "The Lighthouse Depot of France" describes the interesting museum connected with that institution. "Cements" is by Willett Pierson. The usual "Trade Suggestions from United States Consuls" and "Selected Formulæ" are included in this issue.

Contents.

(Illustrated articles are marked with an asterisk.)

RECENTLY PATENTED INVENTIONS.

Mechanical Devices.

SAWMILL LOG-TURNER.—WILLIAM N. ELLIOTT, 107 Kerr Street, Memphis, Tenn. The invention relates to improvements in steam log-turners that employ a toothed bar called a "nigger," which, occupying a generally vertical position, is made to rise and fall beneath the log and also to move laterally and horizontally as it operates on the log above and serves to turn the log or transfer it from the log-deck to the sawmill-carriage. The present invention consists in the special means for cushioning the nigger-bar against shock in its backward and forward thrust in a horizontal direction, as it rises and falls beneath the log.

DRAWING-MACHINE FOR COKE-OVENS.—RICHARD D. MARTIN, of Alderson, Indian Territory. The machine is arranged readily to remove the products from the coke-oven, to separate the ashes from the coke, and to deliver the ashes in separate heaps at one side of the machine. The machine is characterized by the general simplicity of its construction and by an efficiency of operation that leaves nothing to be desired.

AUTOMATIC SPOKE FACING AND TAPERING MACHINE.—GEORGE A. ENSIGN, of Defiance, Ohio. Mr. Ensign has devised for the Defiance Machine Works an apparatus which is especially designed for jointing, facing, and tapering the edges of spokes and for reducing the width of the tenons to the exact dimensions required for accurately fitting the mortises in the hub of the wheel. The machine is completely automatic in operation. The spokes are not handled while in the machine. The spokes are finished in large quantities in a comparatively short time.

TYPEWRITING-MACHINE.—HUBERT BURG, of Mollkirch, Rosheim, Alsace, Germany. The object of the invention is so to arrange the mechanism of a type-wheel typewriter that the construction will be simplified. The mechanical arrangements have for their object to impart rotary movements to the type barrel or wheel by means of a small number of simple devices, while obtaining at the same time a comparatively large number—twenty, for example—of positions different as to the direction of displacement. The simultaneous operation of several keys can in no way injure the mechanism or interfere with the operation.

WIRE-FENCE MACHINE.—JOHN M. BARBER, of St. Charles, Ill. The machine is designed to twist wire strands in the manufacture of picket-fences. The machine is simple, light, and efficient, the movable parts being so arranged as to minimize side strains and to reduce friction.

BALING-PRESS.—ELDRIDGE T. HILL and THOMAS J. HIGHTOWER, of Murfreesboro, Tenn. The invention provides a construction of baling-press which can be manually operated with great power, and wherein a series of bales can be formed and the loose bale in the press conveniently tied while the other bales are in process of formation. A bale leaving the press serves as a bulkhead for the material which is being formed into a bale. The arrangement of parts is such that the machine cannot readily get out of order.

Apparatus for Special Purposes.

AUTOMATIC STARTING APPARATUS.—GEORGE V. ELLIS, Manhattan, New York city. Mr. Ellis has devised a fluid-operated starting device for all kinds of machinery. For example, the apparatus can be employed to start the ejector or other pump used to clear out cesspools and drainage-tanks in cisterns of sewerage. The starting apparatus comprises a pipe commanded by a valve; a cylinder in which a piston works, having connection with the valve to actuate it; and a device tending to move the valve into open position. Fluid pressure is applied to the piston so as to move the valve against the tendency of the device.

CIGARETTE-MAKER.—HENRY H. HARRISON, Manhattan, New York city. The device is to be used by anyone who desires to make his own cigarettes. The cigarette-maker comprises a tubular body portion in which a charging-tube can be slidably fitted. The charging-tube has a longitudinally-extending slot. A closure-plate has a contracted neck pivotally mounted on the end of the body portion, and is capable of fitting within the charging-tube, the slot of the tube receiving the contracted neck of the closure-plate. The closure-plate acts to hold the tobacco in place, the charging-tube moving over the closure-plate; and this plate therefore serves as an abutment to prevent the displacement of the charge. When the charging-tube has been withdrawn from the body-tube, the cigarette will be completed.

PHONOGRAPH-REPRODUCER.—EDWARD KARLOW, Manhattan, New York city. The object of the invention is to provide a device in which the jarring and metallic sounds so disagreeable in many phonograph-reproducers will be eliminated and a clear, loud tone obtained. An arm has one end loosely connected with the diaphragm and is provided at its other end with a foot and between its ends the reproducing point is carried. A hinge connects the foot of the arm with the body of the reproducer, the hinge consisting of rubber secured to oppositely arranged supports and to which the foot of the arm is secured between the supports. As the arm does not engage any metal at and is cemented to the rubber, it cannot rattle at that point; while it is yieldingly mounted so as to be capable of following the vibrations of the point.

CLARIFYING APPARATUS.—CHARLES R. HUDSON, Warren, Ind. Oil prepared for shipment from the fields must be heated during the winter. The salt water mixed with the oil must be "settled-out"; otherwise it would gather in the lines and would freeze and burst the pipes. In the oil-fields it is hence customary to steam the oil. It is the object of the present invention to provide a means by which the oil can be more quickly heated and clarified at a considerably less expense than has heretofore been possible. This object is obtained by the simple apparatus which forms the subject of the present invention.

Vehicles and Their Accessories.

SLEIGH-BRAKE.—AUGUST C. PATZER, Sanborn, Wis. The brake is adapted especially for use on bob-sleighs such as are commonly employed for heavy and light draft purposes. The sleigh-brake consists of brake rods or pins carried in vertical passages in the sleigh runners and movable to engage the surface directly under the runners. Levers are connected at their outer ends with the brake rods or pins, the inner ends of the levers being heavier than the outer ends, so as normally to hold the brake rods or pins in inactive position. The levers can be moved into operative position by a hand-lever.

RUNNING-GEAR FOR HORSELESS CARRIAGES.—GILBERT J. LOOMIS, Westfield, Mass. The object of the invention is to provide an improved construction, which will be very light and of great strength, and which, while rigid enough to bear all strains without undue vibration will have sufficient transverse mobility to accommodate itself to uneven roads. The improved running gear consists of two parts—a front section and a rear section connected by a longitudinal pivot, so that one section can swing transversely in relation to the other, thus securing an easy motion of the carriage on uneven roads.

Railway Appliances.

AIR-BRAKE.—GEORGE W. EDGINGTON, of Coalville, Utah. In the train-pipe an air-discharge valve, normally closed, is arranged. A cam-lever is pivoted at one end, and is adapted to engage the valve to open it when moved from its normal position. A fixed arm is loosely connected with the cam-lever. When the truck runs off the rails and assumes an angular position relatively to the car-body, then the fixed arm imparts a swinging motion to the cam-lever, so that the cam end lifts the valve off its seat and opens the air-discharge valve to the outer air, and thereby allows the escape of air to the train-pipe. The brakes are then set in the usual manner and the derailed car brought to a standstill.

Miscellaneous Inventions.

CRUPPER-BUCKLE.—JAMES T. PRICE, Lincoln, Ill. The crupper-buckle is arranged to work freely at any angle in which it may be placed and to prevent catching of the hair of the horse's tail. The buckle can be manipulated with great ease, and can be readily fastened or manipulated in the dark as well as in the daylight, even if the leather be stiff and hard when frozen.

NECKTIE-CLASP.—Dr. RUEL A. JONES, Stanford, Ky. The necktie-clasp is designed for clasping the ends of a necktie made in two sections. When the free ends of a section become worn or soiled, the sections may be readily detached from the clasp, reversed, end for end, and again secured to the clasp, bringing fresh ends into use. Thus a necktie is provided with four wearing ends instead of two.

KNOCKDOWN BOX.—BOLIVAR N. SYKES, Harrellsville, N. C. The invention is an improvement in knockdown boxes, having for an object to provide a novel construction of box which can be readily erected for use and which can be knocked down and compactly arranged for storage or shipment whenever desired.

SHIELD FOR WOUNDS.—EDWARD C. SHEARS, Lakota, N. D. The purpose of the invention is to provide a shield for attachment to a surgical splint, or to be used in connection with plaster of paris or starch, or other form of bandage or splint, for the safe and convenient septic or antiseptic treatment and protection of wounds and injuries, and for the inclosure and treatment of boils and the like, as well as fractures and dislocations of the fingers, toes and other members.

MOP.—JOHN E. ATKINS, Meriden, Conn. The mop has a handle formed with an annular channel and adapted to have an end inserted into a cake of soap. A bag-like cover is drawn over the cake of soap and is secured in the annular channel. By using the mop the hands are left entirely free.

MEANS FOR PRESERVING SEALS IN TRAPS OF WASHBASINS, ETC.—MARY A. HYDE, Manhattan, New York city. Connected with a water-seal trap is a reservoir, a standpipe being in communication with this connection. Concentric jackets surround the standpipe, the outer jacket receiving water at the top and the inner jacket at the bottom. The inner packet is opened at the top and extends over the outer jacket. A bell has movement over the jackets and is adapted to be seated on the inner jacket. A pressure valve is connected with the interior of the reservoir, and a lever actuates the pressure-valve. The lever is operated by the guide for the bell. The device is an improvement upon a similar apparatus patented by J. P. Hyde, and is considerably more efficient for the reason that the construction avoids resealing by water at the edge of the bell.

HAT-CLEANING PAD.—JOSEPH KRISES, Brooklyn, New York city. The pad is especially adapted for cleaning felt hats, and is so constructed that it can be worn without inconvenience between the sweat-band and adjacent portion of the crown. The pad is always on hand for use. Advertising matter can be placed upon the pad.

WASHSTAND.—ISAAC MASON, Brooklyn, New York city. The body of the washstand is constructed so that it will be provided with two doors opening outward. These doors carry shelves attached to their inner faces, which shelves register with shelves in the stationary portion of the body. One of the shelves in the stationary portion of the body is so formed that a washbowl and pitcher can be conveniently placed thereon, while the smaller shelves connected with the doors are adapted to receive smaller articles.

DRAIN.—JAMES F. SIKES, Palma Sola, Fla. The object of the invention is to provide a drain so arranged as to exclude silt or soil, whereby the water may flow uninterruptedly through the drain for irrigation purposes. The pipe rests upon a filter-bed through which the water must pass so that the silt, by reason of gravity, cannot follow.

FLOWER-POT.—HENRY MILLINGAR, of Merchantville, N. J. This improved flower-pot is to be used temporarily only. It is constructed of light thin strips or sheets of wood which have a peculiar form so that they can be overlapped to form a tapered pot.

EYEGLASSES.—OTTO P. BAILER, 290 Main Street, Memphis, Tenn. The invention is an improvement in the devices used in eyeglasses for connecting the posts with the bow-string. The invention has for its object to provide means by which to prevent the screw which connects the post and bow-string from accidentally becoming loose.

CLASP.—JAMES N. WATT and JOSEPH A. WHITE, of Pendleton, Ore. This clasp is especially useful for fastening suspenders to trousers. It comprises two jaws, moved into gripping position by the positive action of a cam held in active position by the strain on the clasp.

Designs.

ELECTROTHERAPEUTIC DEVICE.—BENJAMIN G. STAUFFER, Harrisburg, Pa. The entire device presents the appearance of a circular disk broken at its quarters by relatively narrow radial slots.

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 this paper.

NEW BOOKS, ETC.

THE OCTIMAL SYSTEM OF NOTATION AND NUMERATION. Combining simplicity with the greatest practical utility. By George H. Cooper. Author's Edition. New Westminster, Canada. 1901. Pamphlet. Pp. 29.

MINERVA. Jahrbuch der Gelehrten Welt. Edited by Dr. K. Trübner, 10th year, 1900-1901. Strassburg, Germany: J. Trübner. 1901. New York: Lemcke & Buechner. 16mo. Pp. 1,235.

It is impossible to put down the present volume without paying a glowing tribute to the editor and publisher for producing such an unique list of the learned of the world. There is not an institution of any kind which is not mentioned, together with a list of the professors, librarians, etc. It is to the scientific world what the "Almanach de Gotha" is to the titled classes. An elaborate index of persons makes reference easy. It is an example of German bookmaking that has rarely been surpassed. It is useful in many ways to institutions, newspapers, etc.

MECHANICAL DRAWING. Written for the use of Naval Cadets at the United States Naval Academy. By F. N. Bartlett, U.S.N. New York: John Wiley & Sons. 1901. 8vo. Pp. 188. Price $3.

The author bases his treatise on the methods in use in the United States Navy as far as these methods can be determined, in general the methods of the Bureau of Steam Engineering being followed. The directions are very explicit.

THE CURRENT ENCYCLOPEDIA, issued monthly by Modern Research Society, Chicago, Ill. $5. Vol. 1, No 1, of this new monthly periodical, arranged in the form of an encyclopædia, tabulating current events in a concise form, accompanied by excellent illustrations, has recently appeared and promises to be a valuable acquisition to the literature of the time. It contains the latest information on such subjects as History, Science, Philosophy, Literature, Legislation, Politics. Industry, Religion, Education, Art, etc.

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.**

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Inquiry No. 1281.—For dealers or manufacturers of machines for grinding dry roots to flour dust.

Inquiry No. 1282.—For manufacturers of small planing mills.

Inquiry No. 1283.—For dealers in razor or tool steel in bars one-eighth by three-quarters of an inch.

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Inquiry No. 1285.—For manufacturers of nickel caps for the ends of an inhaler.

Inquiry No. 1286.—For manufacturers of almond hullers and shellers.

Inquiry No. 1287.—For manufacturers of tin cans for varnish, etc.

Inquiry No. 1288.—For manufacturers of small steam turbines.

Inquiry No. 1289.—For manufacturers of small portable storage batteries.

Inquiry No. 1290.—For water motors of about 30 pounds pressure.

Inquiry No. 1291.—For manufacturers of slot machines (in or near Chicago preferred), also manufacturers of nickel-in-the-slot perfume machines.

Inquiry No. 1292.—For the latest Edison storage battery to run a 25-foot launch.

Inquiry No. 1293.—For some article useful to farmers, to sell through agents.

Inquiry No. 1294.—For the manufacturers of the Jewett typewriter.

Inquiry No. 1295.—For manufacturers of an acetylene gas device in which the carbite falls into an excess of water at given times instead of the whole retort holding the acetylene being immersed.

Inquiry No. 1296.—For brass or steel molds to make small rubber articles, also for vulcanizers.

Inquiry No. 1297.—For large manufacturers and jobbers of tin toys.

Inquiry No. 1298.—For the best envelope addressing machine.

Inquiry No. 1299.—For manufacturers of electric belts.

Inquiry No. 1300.—For manufacturers of wire specialties, as wire cloth, light screens, etc.

Inquiry No. 1301.—For builders of cold storage buildings, small foundries and castings for chain pumps.

Inquiry No. 1302.—For a simple, inexpensive check or controller on a spring mounted reel, employed in mechanical toy.

Inquiry No. 1303.—For manufacturers of novelties for the mail order business.

Inquiry No. 1304.—For the address of the manufacturer of "The New Era Excavator."

Inquiry No. 1305.—For parties to put up a plant for the manufacture of charcoal and the by-products of distilled wood.

Inquiry No. 1306.—For machinery for making butchers' skewers.

Inquiry No. 1307.—For manufacturers of compressed air engines of 2 to 10 h. p.

Inquiry No. 1308.—For manufacturers of springs for turning tables in show windows.

Inquiry No. 1309.—For manufacturers of bakers machinery.

Inquiry No. 1310.—For wholesale dealers in lithographs, illuminated scripture text, etc., of German manufacture.

Inquiry No. 1311.—For manufacturers of paper lamp shades.

Inquiry No. 1312.—For manufacturers of push nipples, such as are used in the construction of radiators.

Inquiry No. 1313.—For manufacturers of cordage machinery.

Inquiry No. 1314.—For manufacturers of unfinished finger rings of brass or steel.

Inquiry No. 1315.—For manufacturers of incandescent light mantles.

Inquiry No. 1316.—For a new cigar-shaped balloon with propellers, etc., without the motor.

Inquiry No. 1317.—For manufacturers of hot-air engine castings.

Inquiry No. 1318.—For manufacturers of machinery for cutting, splitting and bundling fire wood.

Notes & 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.

(3347) F. H. asks: 1. Apart from palladium, what metal is the best for plating reflectors in acetylene cycle lamp? A. Nickel is chiefly used for this purpose. It does not oxidize quickly and can be polished easily. 2. For an induction coil, giving 4 to 5 inches of spark, which is the better form of Tesla coil, the one described in "Bottome El. Instruments" (also in Journal of the Inst. of El. Engineers, Vol. xxi., No. 97), or the one in SUPPLEMENT No. 1087? If the latter, what changes, if any, must be made in coil and condenser to adapt them to my induction coil? A. You will find the coil of SUPPLEMENT No. 1087 all right. Probably no changes will be required. 3. Is there an electrolytic interrupter that will work with so low a voltage as 10? A. No. C. D. C., Query 8203, seems to have had some difficulty in filling barometer tube. Allow me to suggest the method I used. Clean tube carefully, driving plug of cotton wool through it, soak first few plugs in benzine, others dry; close one end of tube over Bunsen burner, gently heating tube all over. Pour in chemically pure mercury to within half an inch of top; hold tube vertically over clean dry basin; run Bunsen burner up and down the tube. Bubbles of air then expand, and tapping the tube causes them to rise and escape. Fill up completely, stretch piece of India rubber measuring 6 inches by 1 over mouth of tube. Having about half-filled the cistern, invert tube, dip into mercury in cistern, and a little manipulation will draw away the strip of rubber. Found method to give good vacuum and to work even with small-bore tubes.

(3348) W. S. P. asks: Suppose on a party line having several lines an extra wire be run around each telephone, not cutting out the telephone at all, but merely making a double line at those points. I suppose this would not injure the speaking properties of telephone but would require double strength of current? A. You can use a shunt around your telephone as you suggest, but we do not think the speaking properties will be as good with it.

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