SCIENTIFIC AMERICAN

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Displacement, 11,800 tons. **Speed,** 19 knots. **Coal Capacity,** 2,000 tons. **Armor:** Belt and sides, 7 inches; gun positions, 10 inches. **Battery:** Four 10-inch; fourteen 7.5-inch; fourteen 3-inch. **Torpedo Tubes,** submerged, 3. **Complement,** 700.

CHILIAN BATTLESHIP "LIBERTAD;" LAUNCHED TEN MONTHS AFTER LAYING OF KEELPLATES.—[See page 133.]

SCIENTIFIC AMERICAN

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NEW YORK, SATURDAY, FEBRUARY 21, 1903.

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.

AN 18-000-TON BATTLESHIP.

Despite the storm of criticism with which it has been assailed, the large-displacement battleship continues to grow both in size and in favor. Proof of this is to be found in the huge 18,000-ton ships which are to form the most important feature of the new building programme of the British navy. In 1882, six battleships were included in the British naval construction estimates, each of 10,600 tons. In 1892, the displacement had risen to 14,150 tons, which was the size of the "Royal Sovereign" class. Then followed the "Majestic" class of 14,000 tons; the "Formidable" class of 15,000 tons, and the "King Edward" class of 16,350 tons; while to-day the designs for 18,000-ton battleships will soon be in the builders' hands. The policy of building battleships of large size is favored in our own navy, the "Connecticut" and "Louisiana" having a displacement of 16,000 tons.

In other respects than that of size, there is a tendency on the part of American and British designers to reach a common type, with certain clearly-marked characteristics. This is particularly noticeable in a comparison of the new 18,000-ton ships with our own 16,000-ton vessels; for it must be confessed that in these last ships the British designers have shown a desire to follow our lead in the make-up and disposition of the armament, as will be seen from the following description:

The main armament of the new ships will consist of four 12-inch guns, located in two barbette turrets, forward and aft, and eight 9.2-inch guns, mounted in four barbette turrets, one at each corner of a central citadel, within which will be carried ten 6-inch rapid-fire guns. This armament will be more powerful than that of the "King Edward" class by four 9.2-inch guns. As compared with the "Connecticut," it will be seen that the armament will be about the same in power; for while the eight 9.2-inch guns constitute a much more powerful battery than the eight 8-inch guns of the "Connecticut," this preponderance is largely offset by the fact that the "Connecticut" carries twelve 7-inch guns as against the ten 6-inch guns of the British vessel. The 8-inch gun is very popular with the officers of our navy, and it is amply sufficient for the attack of armor covering the secondary batteries of the latest foreign vessels. On the other hand, the 9.2-inch is a much more powerful piece; it throws a 380-pound projectile with a muzzle velocity of 2,900 feet per second, and a muzzle energy of 22,160 foot-tons. Our new naval 8-inch piece of 45 calibers throws a 250-pound shell with a velocity of 2,800 feet per second, and an energy at the muzzle of 13,602 foot-tons. The lower power of our piece would be compensated for somewhat by the greater rapidity with which it can be handled; on the other hand, the 9.2-inch gun can pierce any waterline armor afloat at ordinary fighting range. The total muzzle energy of a single round from the main batteries would be 409,552 foot-tons for the "Connecticut" and 417,680 tons for the 18,000-ton ships.

It is chiefly to the increase of its defensive qualities that the extra 2,000 tons displacement of the British ship has been devoted, the protection being of quite an exceptional nature. In addition to the protection of 9 inches of Krupp steel from stem to stern at the waterline, this 9-inch armor covers the whole side of the vessel to the upper deck, giving the equivalent of waterline protection to the whole of the 6-inch battery, the bases of the 9.2-inch and 12-inch gun barbettes, and to the ammunition hoists and the bases of the smokestacks. The whole of the personnel will therefore fight the ship from behind not less than 9 inches of Krupp steel. The speed of these huge vessels is to be 19 knots, and they will each cost $7,000,000 to build and equip.

THE NEW COKE INDUSTRY.

In the past quarter of a century coke has become one of the most important factors in our iron and steel manufacturing interests, and its value for other purposes where a smokeless fire is required has appreciably increased with its extended use. As a statistical factor it was of little more importance than charcoal prior to 1880; but in 1901 nearly 20,000,000 tons of coke were produced in this country. The present demand is even greater, and the production and consumption for the current statistical year will probably exceed anything heretofore noted in our industrial history.

The coke furnaces of the country have an estimated capacity of production for the current year of 25,000,000 tons, and if this sells at the average rate of $2.50 per ton, as it did in 1902, the total output will represent $62,500,000. But coke, like coal, has increased rapidly in value in the past few months, and to-day it is hard to get it at $3 and $4 per ton for furnace coke, and $5 to $12 for foundry coke. These abnormal prices, however, are not likely to continue long. The chief difficulty in the coke industry has been the shortage of railroad cars to move the material to the furnaces for manufacturing, and then delivering the finished product to the consumers. So greatly handicapped have the coke furnaces been in this respect, that nearly half a million tons of coke are held up in the yards for lack of transportation facilities.

Poor transportation facilities affect the coke makers more than almost any other class of manufacturers, for besides requiring cars to carry the finished product to the consumer, the raw materials must be brought to the furnaces over the same lines of traffic. The hauling of coke to the iron and steel mills must necessarily determine to a large extent the cost of smelting. This has in the past year been out of all proportion to the actual conditions which prevail in normal times.

The future requirements of coke can be partly measured by the unparalleled development of our iron and steel trade. It takes on an average about one ton of coke to make each ton of pig iron. In the last statistical year—that of 1901—the total pig-iron product of the country was 15,878,354 long tons. Not all of this, however, was smelted with coke. Some of it was made with anthracite coal, charcoal, bituminous coal, and charcoal and coke mixtures. But the excess of coke produced over pig iron represents to a large extent the actual demand for coke in other lines of work. The conditions of the iron and steel industries in this country at the beginning of the year were never so promising, with the exception of the high cost of coal and coke. While the maximum capacity of the pig-iron plants of the country for 1902 was about 350,000 tons per week, that of 1903 will be much greater, owing to the completion of some twenty-five new blast furnaces, with an estimated capacity of 2,500,000 tons of pig iron a year.

The demand for coke by the blast furnaces for the current year will consequently be much in excess of that of any other year, and to meet this consumption coke makers have made extraordinary additions to their plants. Up to the first of 1901 there were 64,000 coke ovens in this country, with a trifle over 5,000 in the course of construction. During 1902 about 15,000 new bee-hive coke ovens were built, and several thousand more planned for 1903. These new ovens averaged 600 tons each per annum, which would increase the output of coke some 9,000,000 tons.

The by-product coke ovens have in the past few years become important factors in the situation. These ovens are peculiarly arranged and built to use coals that are not suitable for the bee-hive oven. They have been designed recently so that they can coke coals which were formerly considered of no value for this purpose. In 1901 there were 1,165 of these by-product coke ovens, with a total capacity of nearly 1,180,000 tons; but in 1903 there will be some 3,500 of the by-product ovens in operation. This will enable the makers to nearly double their output. The by-product coke output is immeasurably smaller in this country than in any of the coke-making countries of Europe, the percentage being about 5 per cent here against 40 per cent in Germany, and 20 per cent in England. This is due to the fact that the quality of the coals found in this country is relatively higher than in Europe, and the need of such ovens has not been so urgent here. It is also due largely to the fact that the question of economy in fuel has always been studied more carefully in Europe than in the United States.

Coke has found entirely new fields of use in the electrical field in recent years. In the many electrochemical industries established by the harnessing of Niagara, coke is employed for building the electrical furnaces, and for fusing with the different materials in the furnaces. In the manufacture of carborundum coke forms an important part of the mixture, and it is also used for packing the walls of the furnace. The very highest grade of coke is demanded for these electrochemical industries, and some coke ovens make a specialty of supplying products just for them. These industries include the manufacture of such commercial articles as caustic soda, sodium, aluminium, artificial graphite, zinc, and manganese. The demand for the finest coke for these practically new industries is increasing so rapidly that a number of coke ovens have been established near the scene of manufacturing.

The development of the gas engine in the past year has its bearing on the coke industry. The modern blast furnace gas engine is a marvel of modern invention and ingenuity. It takes the gas from the furnaces and utilizes it for generating power for different purposes. This gas used in the modern gas engine performs nearly or quite double the work obtained from it when used for steam heating purposes. In time the gas engine in utilizing the blast furnace gases will make the profits of pig iron production more than doubly profitable. Indeed, it is believed by some that the blast furnaces may in time be erected primarily as great gas generators, and only secondarily for making pig iron.

PROPOSED REPAIRS TO THE EAST RIVER BRIDGE CABLES.

The report of the Board of Engineers appointed last November to decide what repairs should be made to the cables of the Williamsburg Bridge, which were damaged by fire, has found that the annealing of the wires by the heat of the fire left one of the cables, known as cable A, 2.5 per cent weaker than it was before the fire, while cable B was weakened by 6.5 per cent of its original strength. They suggest a method of repairs or reinforcement which will restore cable A, so that it will be only one-quarter of 1 per cent weaker than it was before the fire, while cable B will only lose 2 per cent of its original strength.

Each cable contains thirty-seven strands, and each strand is made up of 208 wires, making a total of 7,696 wires in each cable. The specifications called for an ultimate strength of 200,000 pounds or more to the square inch, but this strength actually ran much higher, being from 8 to 10 per cent greater than the specifications called for, the ultimate strength being from 216,000 to 220,000 pounds to the square inch. The result of the heating of the wires was to anneal and also to lengthen them, the heated wires, after the fire was over, being more or less bowed out from their proper position and not lying parallel with the mass of the cable. The annealing resulting from the fire reduced the strength so greatly, that, in extreme cases, the strength amounted to only 80,000 pounds to the square inch, which was about the ultimate strength at which the wires are drawn in the mill. The heat annealed the wire more or less completely for a depth of four layers. Thus specimens cut from the outer layers showed that, while the uninjured wire had a strength of 223,800 pounds to the square inch, the most injured portions of the burnt wires showed a breaking strength of only 89,900 pounds to the square inch. The reduction of strength decreased in the second, third, and fourth layers, where it fell from 234,000 pounds to the square inch to 210,500 pounds to the square inch, which, by the way, is 10,500 pounds per square inch greater than the specifications called for. A count made of the injured wires shows that 500 have been affected in cable B and 200 in cable A. The injured wires on the top of the cables where they pass over the saddles will be cut out and replaced by new wires, which will be spliced by sleeve nuts to the uninjured ends.

As the injury has taken place at the bend of the cables over the saddles, where the strength should be the greatest, it has been decided, after the wires have been spliced, to add 25 additional wires to cable A, and 200 additional wires to cable B. As the ends of these wires cannot connect with any of the wires in the cables, these being spliced to their own new sections that will be put in, it has been decided to attach these additional wires to the cables by friction. A series of steel bands will be clamped around the cables, at varying distances from the saddle, to the adjoining suspenders on either side, and a certain number of additional wires will be attached to each clamp. There will be three bands on each side of the saddle on cable A and eleven on cable B. Thus twenty wires will run to the outermost band furthest from the saddle and adjoining the first suspender; then twenty wires will be attached to the next band; twenty to the next, etc. On cable B the first band will cover 200 wires, none of which will be fastened to it; the second band will cover 180 wires, twenty of which will be fastened to it, etc. Furthermore, it has been recommended that fireproof flooring be used throughout the whole length of the bridge. It is gratifying to learn that the injury to the cables of this magnificent structure is such that it can be entirely repaired, the bridge as repaired being indeed, because of the high quality of the steel, stronger in its cables than was called for by the contract.

A HARVARD GRANT FROM THE CARNEGIE INSTITUTION.

A grant has recently been made by the Carnegie Institution, for the study of the collection of photographs at the Harvard College Observatory. For many years, two photographic doublets of similar form have been in constant use, photographing the sky night after night. The aperture of each is eight inches, and the focal length about four feet. The first of these photographs was obtained with the Bache telescope in 1885, and since 1889 this instrument has been mounted in Peru, first near Chosica and later at the Arequipa Station of this Observatory, and employed mainly in the study of the southern stars. The 8-inch Draper telescope has, in the same way, been mounted in Cambridge, and used on the northern stars since 1889. About 30,000 eight by ten-inch photographs, each covering a region ten degrees square, have been obtained with each of these telescopes. Photographic charts have been made with these instruments, covering the entire sky on from one hundred to two hundred nights, and showing all stars brighter than about the twelfth magnitude, besides many that are fainter. During the last four years, this work has been supplemented by taking photographs with two anastigmat lenses having clear apertures of about one inch. Each photograph covers a region 30 degrees square, and in general shows stars of the eleventh magnitude and brighter. The number of times the entire sky is covered has thus been greatly increased. The amount of material thus collected has required a special building for its accommodation, and the means of the Observatory have so far permitted but a small part of the astronomical facts contained on the photographs to be gathered. The Henry Draper Memorial has enabled the most important results to be derived from the numerous photographs of the spectra of the stars, and the past history of many of the objects discovered here to be studied. When any object of interest is discovered, the photographs permit its brightness and position to be determined on one hundred or more nights, during the last twelve years, and many important facts not recorded at any other observatory are thus determined. By the aid of the grant mentioned above, a corps of assistants will be organized, whose duty will be the study of the photographs as regards any objects of special interest.

THE STEAM TURBINE.

BY H. M. GLEASON, ASSISTANT NAVAL CONSTRUCTOR, U. S. N.

The steam turbine, although old in principle, is comparatively young in its application to commercial power generators. Since Watt's development of the reciprocating engine, all inventive energy has been employed to perfect a form of power generator which is wrong in principle. If Watt had achieved as great success with a primitive form of rotary engine or steam turbine as he did with the reciprocating engine, it is safe to say that to-day we should have a highly perfected form of steam turbine, and the reciprocating engine would have been looked upon as one of the many queer inventions of the past.

So great has been the inventive genius of the age, that to-day we have a very efficient reciprocating engine, as efficient, perhaps, as this kind of engine will permit of; but who, with any idea of mechanical simplicity, can go into the engine room of any modern steamer without wondering at the ingenious complexity represented there?

To be sure, any machine should be designed for the use intended, and in this way the reciprocating engine is especially adapted for use on certain machines using power exerted in a straight line. The great majority of machines, however, require circular motion, and here the reciprocating engine is handicapped. It may be said, then, that the chief aim in power generation is to develop it along the line of circular motion. For this purpose, leaving other considerations aside, the steam turbine is eminently fitted.

The advantages of the steam turbine over the reciprocating engine are, in general, as follows:

1. The effort of the steam is applied directly without any intervening mechanisms for conversion of motion. This avoids their attendant friction, their costly fitting, and probable lost motion.

2. There being no reciprocating parts, there is no inertia to overcome at the beginning of the stroke, with the necessary consumption of energy required to accelerate them.

3. The absence of reciprocating parts makes it possible to run the shaft at vastly higher speeds than are attainable in a reciprocating engine.

4. The turbine engine becomes very compact from the absence of converting mechanism, and it consequently occupies very little room.

5. The engine has no dead center, but will start from rest in any position.

6. The engine has either no valve gearing, or that which it has is of the simplest character.

7. The simplicity of the engine and absence of expensive mechanism make it cheap to build and, therefore, it should be cheap to buy.

8. Very little skill is required to run the engine, and fewer engines are needed, and there is a consequent saving in the cost of handling.

9. The absence of reciprocating rods and dead-centers results in a construction in which the pressure of condensed steam in the engine does no harm. Water does not stop the engine from turning, it cannot endanger the engine casing. The engine can be started, even if under water, by simply opening the valve which admits pressure to the turbine blades; it will start with solid water as in the case of the water turbine.

10. Its incased construction and the above peculiarity adapt it for outdoor service and places exposed to low temperatures. Weather does it practically no harm, and its protection from outside injury makes it particularly serviceable in mining and stone quarrying.

11. The turbine is easily controlled; it is stopped by simply turning off the steam by means of an ordinary valve, and started again by turning on the valve.

The above advantages apply to its use in general, but for the propulsion of ships it has especial advantages:

1. The absence of vibrations, which are so troublesome in reciprocating engines. The study of vibrations in a reciprocating engine has called forth many valuable and scientific papers by engineers who have made this subject a special study. The necessity of the balancing of engines in ships need not be commented upon, for who has not suffered from it, even on the largest and best designed of our present-day passenger steamers. The continual shaking which the hulls and fittings of ships are subjected to is one great cause of their frequent need of repairs, some, it is true, of minor consequence, but the loss of time incurred in making these seemingly minor repairs results in an appreciable decrease in the vessel's earning capacity. And, when balanced at one speed, it does not follow that the same condition will follow at other speeds; in fact, it generally does not follow. With the turbine engine, all this loss of time and inconvenience is avoided.

2. The use of the turbine engine effects a great saving in weight of machinery. The question of weights on a ship is a very important one, and where a saving can be made in the propulsive machinery, a consequent gain can be effected in cargo or passenger accommodation, in the case of a merchant vessel, or, in the case of a warship, a gain in guns, armor or coal. The weight of machinery per I. H. P. in the case of the "Turbinia" is 21.3 pounds, while in the best designed modern vessels the average weight per I. H. P. is about 150 pounds. These figures show what advantages the turbine has in this connection. Where the weight problem is so vital, as in the case of a battleship, the use of turbines would mean a great gain in offensive or defensive qualities.

3. The perfect balancing of the turbine engine does away with increased weight in construction of engine bedding and hull fittings, which are necessary to withstand continual vibrations and strains.

4. The increase in stability gained by the use of the turbine is greatly due to the low position of the center of gravity of the engine. This is a very important feature in the turbine, as it enables vessels to carry heavy weights on the upper decks without endangering the stability of the vessel. In the case of a warship this would allow heavy guns and armor to occupy a position of greater elevation than is admissible now; and, in the case of a merchant ship, would enable her to go to sea in a light condition in greater safety. The turbine situated well down in the ship's body would be protected from injury in action without the necessity of armor decks, beyond protection from falling projectiles.

5. The lives of the engine-room crew are not endangered by intricate, fast-moving parts. It is not necessary to call to mind the marine disasters that have been caused by the breaking of a shaft and the consequent racing of the engines, resulting in completely wrecking the engine room and not infrequently injuring the hull seriously. From all this the turbine is free.

6. A much smaller engine-room force is required. This results in a great saving in running expenses, and, in the case of a warship, would enable more men to be carried to man the guns.

7. Last, but not least, of all, the turbine requires very little lubrication, resulting in a great saving of lubricating oil, which in a large vessel is no small item.

The best-known turbines to-day are the Parsons-Westinghouse, the DeLaval, and the Dow. All these different classes of turbines are designed to derive the maximum effect of the kinetic energy of steam under expansion, and this requires that the turbine shaft revolve at a very high speed. This makes the turbine specially adaptable for electric generators, and its use in this connection is becoming general.

For marine propulsion, a high speed of revolution of the propellers is not desirable beyond a certain limit, at which cavitation results. Thus, in some cases, it is necessary to reduce the speed by gearing down. The propellers of the "Turbinia," at a speed of 34½ knots per hour, made 2,000 revolutions per minute. From the limited experience with high-speed propellers, it has been found that under certain conditions the ship does not answer to her helm in the usual way; but this difficulty can be overcome by putting the rudder forward of the propellers.

The question of efficiency is one to be considered. Comparing it with a compound or triple expansion condensing engine, the steam turbine over the widest range of loads is, for general purposes, the most desirable. This the steam turbine has done, as proven by trials, in which the efficiency from full load to half load varied but 8 per cent; this is a far better performance than any attained by reciprocating engines. With the improvements in design that are sure to be made, the turbine's efficiency will be demonstrated even to the most skeptical engineers.

The great problem in steam turbine design is to devise a perfectly reversible one. This is done in marine turbines at present by having a separate turbine on the same shaft—the reversing turbine running idly in a vacuum when the ahead turbine is working, and *vice versa.*

There is nothing that can stay the improvement and popularity of a machine or process which saves money; thus we can see for the steam turbine a great future, both in commercial power generation, and marine propulsion. The reciprocating engine, although very highly developed and universally used, has a dangerous rival in the simple turbine, and there is nothing that appeals to the American mechanic more than simplicity.

SCIENCE NOTES.

Profs. Haga and Wind, of Holland, in 1899 announced that the X-rays were subject to diffraction. They have recently repeated their experiments and have again proved the existence of diffraction phenomena, and conclude that there is no longer a doubt that the X-rays are, like light waves, perturbations of the equilibrium of the ether. They have sought to evaluate the wave-lengths of the X-radiations, and conclude that these radiations have wave-lengths of the same order of magnitude as light waves.

Most people are aware of the power of egg shells to resist external pressure on the ends, but not many would credit the results of tests recently made, which appear to be genuine. Eight ordinary hen's eggs were submitted to pressure applied externally all over the surface of the shell, and the breaking pressures varied between 400 pounds and 675 pounds per square inch. With the stresses applied internally to twelve eggs, these gave way at pressures varying between 32 pounds and 65 pounds per square inch. The pressure required to crush the eggs varied between 40 pounds and 75 pounds. The average thickness of the shells was 13-1000 inch.

The recommendations of the Advisory Board of the Carnegie Institution are of exceptional interest. Prof. S. P. Langley tells of the wide discrepancy of results obtained in an effort to determine the solar constant, the unit of heat exerted by the sun's rays on a given surface in a given time. He gives as the probable cause of the divergence, the absorptive qualities of different layers of atmosphere which absorb heat from the sun's rays. He also suggests a possible periodic variation in the power of the sun. In view of the important effect of the heat imparted by the sun's rays on all life, Prof. Langley advocates the establishment of two laboratories close to the equator, at the greatest possible difference of altitude and yet within sight of each other, so that, under like atmospheric and other conditions, simultaneous observations could be taken, and the variation produced by difference of altitude accurately recorded. Dr. D. S. Jordan advocates the sending of an expedition to study ichthyology in the Pacific Ocean and to make a marine biological survey similar to that being conducted by the United States Fish Commission in American waters. Prof. C. K. Gilbert, of Washington, proposes a deep boring in plutonic rock for the purpose of ascertaining the temperature gradients in the earth's crust. He recommends that a mass of great age be selected, one which has not for many periods been subjected to change, and that a boring be made with some instrument similar to the diamond drill, so that the core produced could be made the subject of special investigation. With such a boring completed to a great depth, temperature observations could be taken at numerous levels, which would contribute largely to geological knowledge, and might prove of great value in the study of seismic disturbance. Dr. Ladd, of Yale, recommends a certain line of work in his special department of psychology and philosophy. Of most importance he considers a bureau of information, a sort of psychological clearing house for the interchange of not only definite results, but of attempted investigations, partial results, etc., with a view to keeping all psychologists posted as to what is being done. Dr. C. O. Whitman, of the University of Chicago, recommends a biological farm for the study of heredity, variation, and evolution.

THE OZONE WATERWORKS AT WIESBADEN AND PADERBORN.

The city of Wiesbaden has for years been drawing its supply of drinking water from the Taunus springs, which yield excellent water. But the continued growth of the town has forced the municipal authorities to provide for some means of supply beyond the limited source of the Taunus springs, and with this end in view the surface water from wells sunk in the plane of the Rhine has been subjected to a special purification, which turns it from a water of inferior value, fit only for general economical purposes, into an excellent drinking water. The method of purification is a novel one, which has never before been applied on a technical scale. Instead of the water being filtered, as usual, it is treated with ozonized air prepared in ozonizers of the Siemens pattern. The whole plant has been put up by Siemens & Halske, of Berlin. Its maximum output is 66,000 gallons per hour, but normally only 33,000 gallons are consumed, so that there is a surplus of 100 per cent available.

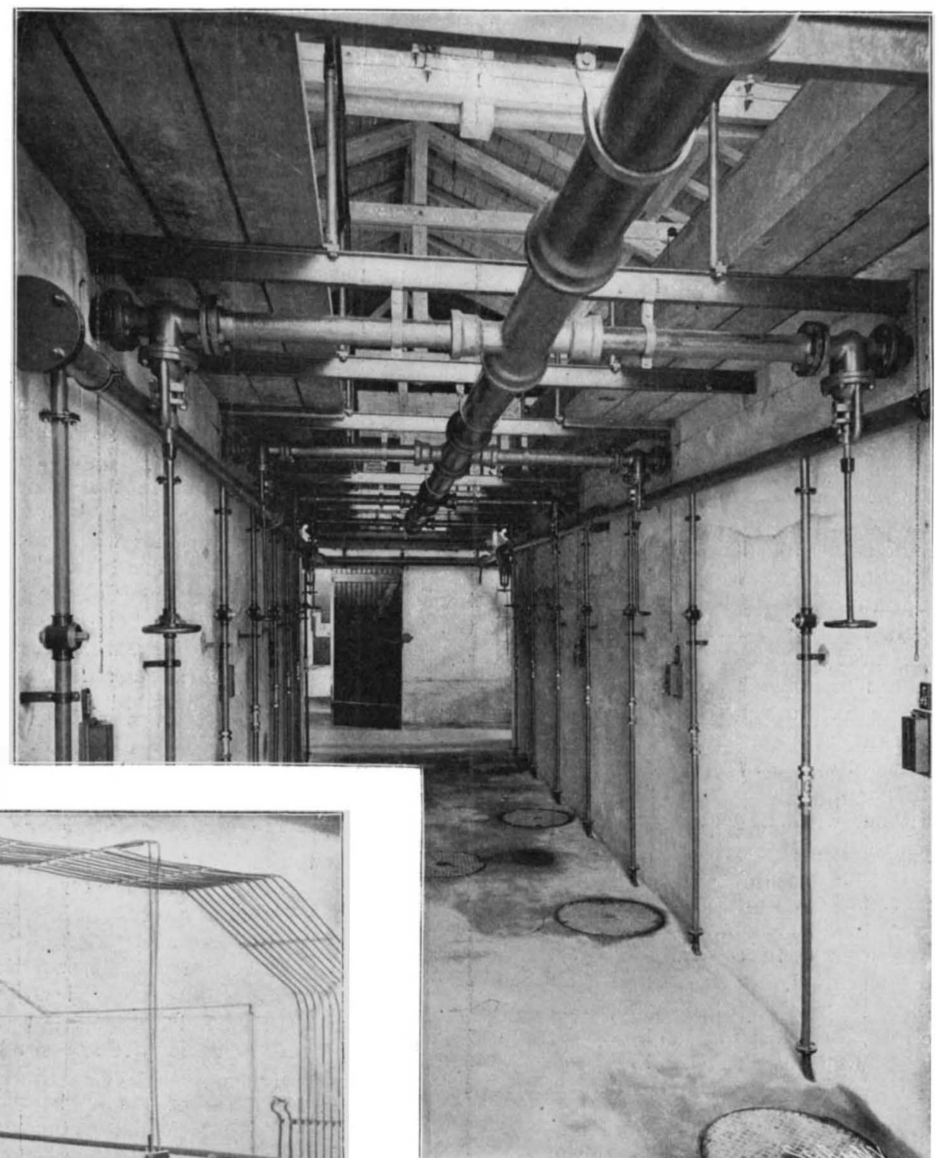
THE OZONIZERS AT THE WIESBADEN PLANT.

Every part of the installation is duplicated, so that it can be worked in two absolutely independent halves, and moreover, if any particular part becomes unfit, the connections are so arranged that it can always be replaced by the corresponding duplicate part.

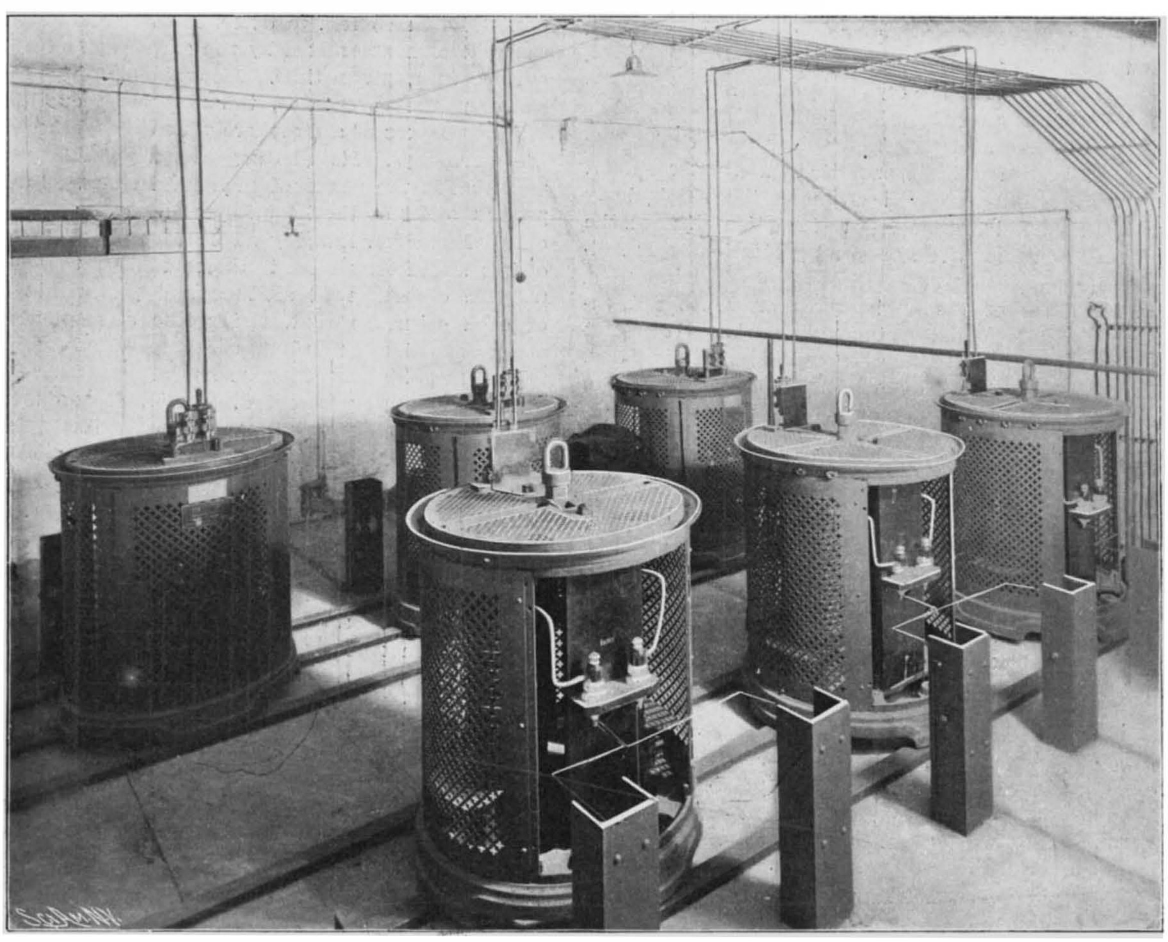
The equipment is as follows: A pair of engines drive a direct and an alternating current dynamo each, which in their turn furnish the power for the motors of the pumps and the current for the ozonizers, this current being transformed up to the requisite 8,000 volts by six step-up transformers (see figure). The building containing the plant is divided into three rooms: 1, the engine room; 2, the room for the ozonizers and transformers; and 3, the room for the sterilizing towers.

In the engine room are placed two 60 horse power Wolf's engines, two direct and two alternating current dynamos, two centrifugal pumps, and two fans to supply the air current for the ozonizers. The portion of the building containing the ozonizers is two stories high. On the ground floor it accommodates forty-eight ozonizers placed in two groups separated by a gangway (see figure). Each of these groups forms part of one of the two independent plants. It has twenty-four ozonizers arranged in four rows, one above the other, of which every eight are connected to one of the six transformers. Such a series of eight ozonizers furnishes the quantity of ozonized air required for one sterilizing tower. The ozonizers are of the Siemens type; the one pole consists of the cooling water of the glass tube, and is earthed, while the other pole, connected to the transformers, is placed in an inaccessible position and therefore causes no danger to the attendant. The ozonizing tubes are inclosed in a cast-iron case consisting of three parts: a completely closed central portion, into which are firmly screwed the eight ozone tubes; an upper part, functioning as reservoir and distributer of the air; and a lower part forming the ozone-collecting chamber. In the upper chamber, removed from all possible touch of the attendant, are fixed the terminals from the transformers. On the floor of the lower compartment are placed the high potential cylinders with their insulating glass rods, and in addition an automatic device to prevent a short circuit through any leakage of the cooling water. This consists simply of a strip of filter paper stretched across a metal spring. If the filter paper gets moist it tears, the spring opens out and automatically places the particular ozonizer out of work.

The cover, bottom, and front wall of cast-iron case are made of thick plate glass, so that the blue shimmer of the silent charge, a certain sign of the proper working of the apparatus, can be watched by the man in charge of the room, which is kept dark. Owing to the careful protection of the high potential terminal, the apparatus can be fearlessly and safely handled by the workmen. The air supply is fed by means of a main pipe running along the row of ozonizers and sending branches to them severally.



THE STERILIZING TOWERS.



THE HIGH POTENTIAL TRANSFORMERS.

The brickwork sterilized towers are divided into four sections, and are placed in two rows, of which one forms the reserve plant. These towers receive from a common feed pipe the unpurified water above. They are about thirteen feet high, and are filled to a height of some six feet with coarse gravel. The water trickles in a fine stream down this gravel, meeting a slow current of ozonized air ascending under a slight excess of pressure. The feed pipe is provided with a conical valve which automatically stops the supply of water, if at any time any part of the ozonizers is out of order. The quantity of water passing down through each tower is 11,000 gallons per hour, and the volume of air passing up in the same time is 21,000 gallons. At the bottom of each tower there is a collecting tank for the sterilized water, from which the latter is pumped to the high-level reservoir.

Due provisions are made against accidents interfering with the working of any particular portion of the ozonizing plant. The disturbances which are liable to occur are two:

1. The current in the electrical apparatus may fail.

2. The current of air through the plant may fail.

In either case an automatic device leads to the closing of the valve through which water is admitted to the sterilizing towers, and at the same time a bell informs the attendant of the mishap. In this way the supply of unsterilized water to the consumers is effectually prevented by means of apparatus which is of the simplest construction and easily controlled.

Each half of the plant, yielding a supply of 33,000 gallons, expends 50 horse power, of which 27 go to the ozonizers and about 22 to the pumping plant, the remainder being used up for the air blast, for feeding the boiler, etc.

The cost of the plant figures out to one and one-third cents per 1,000 gallons of sterilized water, of which about one-third of a cent falls to the coal consumed in effecting the ozonization. (The price of one ton of coal yielding 7.7 times its weight of steam being reckoned at $5.) To this must be added about two-thirds of a cent in payment of interest and for keeping in repair. But it must be remarked that the Wiesbaden plant is not typical, as there were no pre-existing water works, and pumping has to be done, which does not properly form part of the work of an ozonizing plant.

Prof. Proskauer and Dr. Schüder, of the Koch Institute for Infectious Diseases at Berlin, have carefully investigated the efficiency of the ozone sterilizing process, with results which are highly satisfactory. They worked with water which was grossly infected with virulent bacilli (of the cholera and typhus kind). Their result only confirmed the conclusion previously arrived at in the preliminary experiments at Martinikenfelde by the same investigators, namely, that ozone, in the concentration in which it issues from the Siemens apparatus, will destroy all pathogenic bacteria and nearly all harmless microbes, excepting just a few highly resistant and innocent forms, provided a suitable gravel filling is used in the sterilizing towers.

A month after the opening of the Wiesbaden water works, there was also inaugurated a similar plant, on a smaller scale, however, at Paderborn. The sterilizing apparatus of this is a precise copy of that at Wiesbaden, the only difference being that the water delivered from the sterilizing towers is allowed to flow down in a series of cascades, so as to work out the last traces of ozone.

The Paderborn waterworks have to supply 13,000 to 15,000 gallons of sterilized water daily. The plant has nine ozonizers of the Siemens type (of which three are for reserve) and two sterilizing towers with four sections each. The power for the electric plant is supplied from a gas engine. The former consists of direct and alternating current dynamos, two blowers and three transformers, and has arrangements preventing the supply of unsterilized water similar to those at Wiesbaden. The cost of power is a little higher at Paderborn, but on the other hand there is less ozone used per gallon of water, so that the total expenses are much the same as at Wiesbaden.

The establishment of the plants at Wiesbaden and Paderborn marks the début from the laboratory into the technical world of a process which is likely to prove a serious rival to older methods of purifying drinking waters, which have been in vogue hitherto.

THE NEW CHILIAN BATTLESHIP "LIBERTAD."

The striking illustration on our front page is reproduced from a photograph taken from the launching ways, just as the new Chilian battleship "Libertad" had taken the water. The heavy chains which are seen hanging from the sides of the ship were dropped to assist by their friction upon the bottom in checking the vessel's way through the water, while a part of her launching cradle will be noticed still in position under her starboard bow. We have seen many handsome photographs of a launch, but never one that approached this in dramatic interest.

The "Libertad" was launched on January 6 at the yards of Messrs. Vickers, Sons & Maxim, Barrow-in-Furness, England. She is a sister ship to the "Constitucion," which was recently launched for the Chilian government by Armstrong, Whitworth & Co. from the Elswick shipyard, Newcastle.

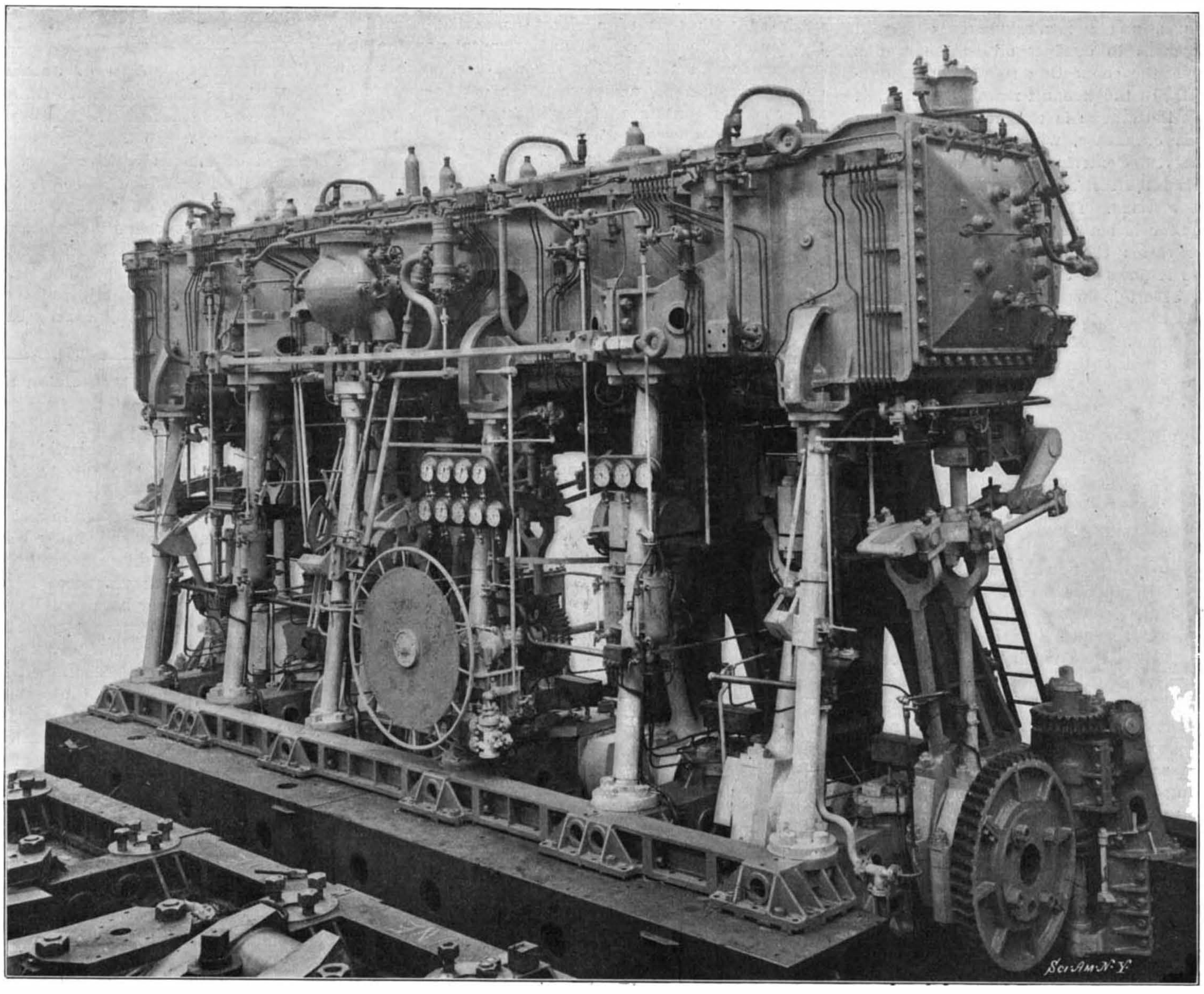
It is claimed for the "Libertad," and we think with much show of truth, that she is, for her size—11,800 tons—the most powerful fighting ship afloat. The European-built Chilian vessels, probably because they have come chiefly from the Armstrong yards, are all remarkable for their powerful offensive qualities, the armament of these vessels being, in proportion to their displacement, more powerful than that of any ships in the world; unless indeed we make an exception in the case of the United States navy.

The "Libertad" is 436 feet long and 71 feet broad, and her mean draft is 24 feet 7½ inches. Her motive power consists of Yarrow boilers of the large-tube type, and twin-screw, triple-expansion engines of 12,500 horse power, and her estimated sea speed is 19 knots an hour. The normal coal capacity is 800 tons, but the full bunker capacity is 2,000 tons. The vessel will carry a complement of 700 officers and men.

The armament consists of four 10-inch breech-loading rifles with quick-action breech mechanism; fourteen 7.5-inch rapid-fire guns, fourteen 3-inch rapid-firers; four 6-pounders; four Maxims, and three submerged torpedo tubes; and from this heavy battery it is estimated that with all the guns firing at their maximum speed, this vessel could deliver in one minute 13½ tons of metal whose combined energy would amount to 1,700,000 foot-tons. In explanation of this great total, it is sufficient to mention that the guns are all of the modern, long-caliber, high-velocity type, with the latest pattern of breech mechanism designed to facilitate rapid loading. Thus, the 10-inch guns will fire a 500-pound shell with a muzzle velocity of 2,850 feet per second and a muzzle energy of 28,160 foot-tons. At the muzzle these guns will be capable of penetrating 31 inches of steel armor. The 7.5-inch gun of the broadside battery is a 50-caliber piece, which fires a 200-pound shell with a muzzle velocity of 3,018 feet per second, and a muzzle energy of 12,638 foot-tons. This piece, which can fire eight rounds per minute and has, therefore, about equal rapidity of fire with the 6-inch piece, can penetrate at the muzzle nearly the same thickness of steel plate as the 10-inch gun, or 29.4 inches. The adoption of such a heavy gun for the secondary battery is in accordance with the best modern practice, which recognizes that the 6-inch piece is not sufficiently powerful to penetrate the modern Krupp armor with which the secondary batteries of modern warships are protected. This 7.5-inch gun, however, is capable of effecting penetration at ordinary battle ranges, and therefore marks a great advance on the secondary batteries carried by most existing warships and cruisers.

While the defensive features of the "Libertad" are, perhaps, not quite equal to her tremendous powers of offense, they are fully up to the average of the latest ships. She carries a practically complete belt at the water line which has a maximum thickness of 7 inches amidships and is associated with athwartship screen bulkheads 10 inches in thickness. This belt is 8 feet in depth. Side armor of the same thickness extends to the upper deck over the whole side of the ship lying between the two main barbettes, and by its association with transverse bulkheads of 6-inch armor, it forms a complete armored central citadel. The upper deck is formed of 1-inch steel plating, while the protective deck, which is 1½ inches in thickness within the citadel and 3 inches in thickness at the ends outside the citadel, extends completely from stem to stern at the level of the top of the waterline belt. The barbettes for the 10-inch guns are 10 inches in thickness in the front where they project beyond the central citadel armor and 8 inches in the rear. The 7.5-inch guns are carried, four of them in casemates on the upper deck at the four corners of the central citadel, and the other ten are within the citadel on the gun deck, five on either side. This battery of ten guns is further protected by 1-inch screens of steel plating placed transversely between each pair of guns. These two battleships will be considerably the most powerful war vessels in the Chilian fleet, which possesses some of the most notable armored cruisers in existence.

Not the least remarkable feature about the "Libertad" is the great speed at which she has been built. The first keel plate was laid March 13, 1902, and the launch took place on January 6, 1903, the vessel being therefore, completed in the remarkably short space of ten months. We commend this record to the consideration of our private shipbuilding firms, who are largely responsible for the backward condition of our navy. The contract for the construction of the "Missouri" (which is a vessel only 400 tons larger than the "Libertad") was signed December 30, 1898. Last December, after the expiration of four years, the vessel was no less than twenty months behind contract, and she is not yet completed.



THE QUADRUPLE-EXPANSION ENGINES OF THE "LIBERTAD."

Automobile News.

Now that automobiles have shown their capabilities on the road for transporting suburban sight-seeing parties, as shown by the Paris-Versailles touring buses and the New York-Tarrytown Mobile wagonettes that were run daily last summer, automobile cars are soon to be introduced on French and English railway lines for fast speeding over long distances and for taking care of suburban traffic respectively. In France, the Serpollet steam motor and flash boiler is to be used to propel single cars rapidly over long distances, while in England the Napier gasoline motor, of a type similar to that on the car that won the Gordon-Bennett race last year, is to be used on individual cars over a 30-mile stretch of track. The service required in this section is not frequent enough to warrant the installation of an electric equipment, so gasoline motor cars are to be used, and these will reduce the running time over steam trains by about 20 per cent, owing to their being more easily and quickly accelerated. From present indications, it looks as if the automobile is destined to revolutionize not only road traffic, but traffic on rails as well.

One great improvement that the French manufacturers have made on their machines this year is the method of lubricating the motor. Instead of depending on splash lubrication alone for oiling every part of the engine, positive oil feeds are led to each of the crankshaft bearings, and the crankshaft is pierced with suitable passages to conduct oil to the cranks themselves, so that the connecting rod boxes also receive plenty of oil. In the Renault motor, the oil that is splashed up by the cranks is caught in small cups at the top of the crankcase, which feed the major bearings by gravity. Centrifugal force is depended upon to send this oil afterward through small holes to the cranks themselves. The new de Dion-Bouton double-cylinder motor has a small pump driven by a worm gear, that raises the oil to the top of the crankcase, whence it flows to the bearings by gravity. A sufficient bath of oil is kept in the crankcase all the time, to splash up and lubricate the pistons. The better oiling arrangements of the motor conduce to longer life and more efficient service, and they should be introduced as far as possible on American gasoline cars.

The legislatures of many of the different States are at present considering bills regulating the speed and operation of automobiles. Connecticut, which has had the most sensible law imposing a speed limit of fifteen miles an hour in the country and twelve miles in cities and towns, is threatened through the efforts to distinguish themselves of some of her would-be farmer legislators; Massachusetts is considering a bill requiring that all operators of autos shall be registered, and prohibiting the licensing of any car capable of traveling faster than twenty miles an hour; while it remains for Maine to try to bring anti-autoists back to their senses by considering a bill providing a speed limit of eight and twenty miles an hour in towns and country, respectively. In every instance, the automobile clubs are fighting the adverse legislation and attempting to forestall it with bills giving equal rights to autoists and the drivers of horses.

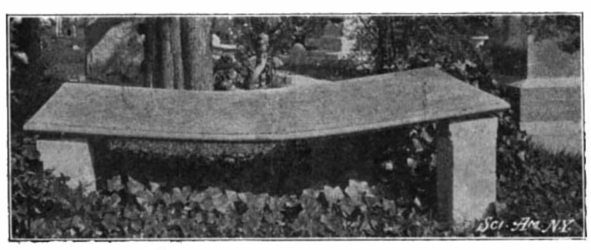
Four hundred dollars damages were awarded an automobilist of New Haven, Conn., recently because of injuries received by being thrown from his machine, which ran into a hole in the pavement between the trolley tracks 48x7x4 inches deep. The judge held that the city was primarily responsible for the condition of the pavement, but that it can exact settlement from the trolley company, as the latter, under the law, is responsible for the pavement between its tracks. This is one of the few cases where the autoist has come out victorious.

Another interesting decision has just been made by a judge in Bridgeport, Conn., which, while not affecting automobiles directly, throws some light on the right of way of trolley cars on country roads. A hack was being driven with two wheels in the track at 12:40 A. M. one dark, stormy night last winter. A car came along behind it and ran into it, throwing it down a small bank and turning it upside down. Neither the occupants nor the driver were seriously injured, but the driver was awarded $500 damages on the ground that the company was to blame in not providing a sufficiently powerful headlight for the motorman to see an object on the track in time to stop the car. The motorman testified that the gong was rung just before he saw the hack. In handing down his decision, Judge Wheeler said: "The company has no exclusive or paramount right to the use of the roadway between the tracks. It must operate its cars in the knowledge that the public has a right to use its tracks as a part of the highway. The traveler must recognize that the car cannot proceed save upon the track, and hence he must turn off from the track, when he knows the car is approaching, within reasonable time to allow it to pass. When a traveler enters upon a car track in advance of an approaching car, he must, in the exercise of reasonable care, do what he can to avoid accident, and ordinarily, if he turn upon the tracks so closely in advance of a car that an accident is inevitable or probable, such conduct will of itself be negligent. The traveler already upon the track is not obliged to keep looking around to see if a car be approaching. Such a duty on his part would be inconsistent with his right to the reasonable use to that part of the highway. When the traveler hears an approaching car, it is his duty to turn out. When he ought to hear it, not to turn out would be an important consideration in measuring his own freedom from negligence." Under the conditions given, however, that the driver did not hear it was no fault of his, and the company was to blame for not taking proper precautions toward the avoidance of accident.

THE SPONTANEOUS BENDING OF MARBLE.

One of our correspondents has sent us a photograph, which we have herewith reproduced, of a bent marble slab in Rock Creek Cemetery, Washington, D. C. The picture brings out a curious phenomenon which may be quite commonly observed in old graveyards. The slab in question has been in position over half a century, judging from the inscription, and during this time has sagged over three inches at the center. Its length is 70 inches, width 35 inches, and it has a thickness of 2 inches. The peculiar phenomenon is not to be confused with that of a slight concavity formed at the center of a slab placed in horizontal position and exposed for a long period to the weather. Such a concavity is caused by a slow solution of the marble in water caught on its surface, whereas in the present instance the thickness at the center of the stone does not vary materially from that at the sides, but a marked curvature is shown on both surfaces. In seeking for an explanation of this curvature, one is at first tempted to consider marble as a fluid, such as sealing wax or pitch, but possessed of much greater viscosity. Pitch in cold temperature is brittle and has all the appearance of a solid, but a heavier substance placed on the surface will, in time, sink to the bottom, and a lighter substance will very slowly float from the bottom of the pitch to the top. However, in the present instance, this explanation is not satisfactory.

For an authoritative opinion on the subject, we have submitted the question to the Director of the United States Geological Survey, and have been referred by



MARBLE SLAB BENT BY ITS OWN WEIGHT.

him to Vol. X. of the Tenth Census Reports, which contains some notes compiled by Alexis A. Julien, on similar occurrences in Europe, where the matter has been studied by some prominent geologists. One of the instances given is that of a slab in the marble veneer of the facade at St. Mark's, Venice, which at its lower end bulges 2¾ inches from the backing. The slab faces westward, and was found to become very warm in the afternoon sun, while its rear surface was kept cool by the backing. Another striking example may be found in the Alhambra in Granada, Spain. One of the two doorways that have been christened "La Mezquita" comprises three slabs of marble, one resting as a lintel on the other two, which are placed upright. A subsidence of the wall on the right side has exerted an enormous thrust upon one of the uprights, and the marble instead of breaking has simply bent outward about three inches. In the quarries near Rutland, Vt., the bending of thin slabs of marble supported only at the ends has frequently been observed. Fleurean de Bellevue discovered a dolomite possessed of this property, which he attributed to "a state of desiccation which has lessened the adherence of the molecules of the stone." De Bellevue seemingly confirmed this by experiments, which showed that inflexible varieties of marble, when heated, became flexible. However, owing to the exceedingly small quantity of water present in marble, this explanation is not satisfactory. A better solution of the problem has been furnished us by Geikie, who says that "irregular and closely contiguous grains of calcite which make up a white marble are united by no cement, and have apparently a feeble coherence." Prof. Julien's opinion is that "their contiguous crystallization has left them in a state of tension, on account of which the least force applied through pressure from without, or of the unsupported weight of the stone, or from external expansion by heat or frost, produces a separation of the interstitial planes in the minute rifts. Such a condition permits the play of the grains upon each other and considerable motion, as illustrated in the commonly observed sharp foldings of strata of granular limestones without fractures or faults. In such cases also I have observed that the mutual attrition of the grains has been sometimes sufficient to convert their angular, often rhomboidal, original contours into circular outlines, the interstices between the rounded grains being evidently filled up by much smaller fragments and rubbed-off particles."

Dr. Bedell's Double Electric Transmission.

In the current Supplement we publish a discussion by Dr. Frederick Bedell, of Cornell University, on the joint transmission of direct and alternating currents simultaneously over the same set of wires. The "common conductor system," of which he is the inventor, requires two pairs of wires, each pair constituting a complete circuit for direct current. By coupling the forwarding wire of one circuit to the return wire of the other, the two will serve as a path for an alternating current, while the remaining two wires may be coupled for another alternating current. The course of each alternating current will be first along the forwarding wire and then along a return wire, according to the alternating directions of its flow, the circuit being completed through the ground. Thus the currents will not interfere with each other and the fluctuations of an alternating current will not be felt in the direct current circuits sharing the same wires.

The Death of James Glaisher.

With the death of James Glaisher there has passed away an old aeronaut. Forty years ago his exploits kept him much in the public eye. In 1862 he made a series of famous balloon trips. Ascending with Mr. Coxwell in a balloon of 95,000 cubic feet capacity, he reached a height of 26,177 feet. On September 5, in an ascent at Wolverhampton, he and his companion were nearly frozen to death. After registering observations up to a height of 36,000 feet Mr. Glaisher became unconscious. Mr. Coxwell contrived to pull the valve string with his teeth, thereby causing the balloon to descend.

The Industrial Exhibition at Osaka in 1903.

Osaka, one of the three imperial cities of Japan, is the center of great activity at this time, preparing for the Fifth National Industrial Exhibition, to be held there from March 1 to July 31 of this year. The exhibition, which is situated at Imamiya in the southern part of Osaka, will surpass in magnitude and beauty all preceding ones, and will bring before the public eye a fuller, more general representation of Japanese arts, manufactures, and resources in their latest development than has ever been seen before. The exhibit will be under the direct management of the Imperial Commission which is presided over by His Imperial Highness, Prince Kan-in. There will be special buildings for classified groups of the exhibits, and important among them are those of forestry, fine arts, agriculture, fisheries, manufactures, education, zoology, foreign samples, transportation, greenhouse, cold storage, aquarium, and machinery. There will also be bazars, restaurants, tea-houses, and the Ceremonial Hall within the grounds. Visitors to the exhibition will be fortunate in witnessing the two great religious festivals which will be celebrated at that time. The festival of Tennoiji will gather over ten thousand priests to Osaka from all over Japan to parade through the streets in their ceremonial robes of rich brocades and brilliant colors. To those who attend the exhibition will be granted special privileges and free access to many places usually closed to all visitors, both foreign and Japanese.

Carnegie Institute's Grants to Johns Hopkins University.

The Carnegie Institute has made five grants of money to the members of Johns Hopkins faculty to assist original researches. They are as follows:

To Dr. Harmon N. Morse, Professor of Analytical Chemistry, $1,500 for an assistant in his researches upon the new method he has evolved for measurement of osmotic pressures.

To Prof. R. W. Wood, $1,000 to maintain a research assistant in his work. He has appointed Thomas Sidney Elston of the University of California to the position.

Dr. H. C. Jones, in new physical chemistry as it is studied in America, gets $1,000 for an assistant in his researches. Frederick Hutton Getman, of Stamford, Conn., receives the appointment. His doctoral dissertation deals with an important problem in physical chemistry.

Dr. J. J. Abel, Professor of Physiological Chemistry, $1,000, for the purchase of apparatus necessary to his researches in that subject. He is a leader in this branch of science in America.

Dr. J. B. Whitehead, in the physical department, has received a liberal grant to carry forward a research in the theory of a magnetic field developed by Maxwell, the English scientist.

Correspondence.

Some Suggestions in Civil Engineering.

To the Editor of the Scientific American:

The engineering projects outlined below may embody some patentable features, but the writer has decided to offer them to the public for what they are worth.

The first is a new method of constructing tunnels under deep harbors or straits, so as to avoid the heavy grades, and also reduce the cost; the second provides a means of retaining the high-water level in harbors, subjected to the action of heavy tides, and with large rivers flowing into them, as in the case of the harbor of this city (St. John, N. B.); the third is a more extended application of the latter scheme, so as to render rivers, with elevated banks, navigable without the aid of canals, where rapids and shallows must be passed; and the fourth shows how to use glaciers, easily accessible, like the Great Glacier on the C. P. Railway, for cold storage purposes. The last is very simple, and need not be described at length, as it would only be necessary to dig a tunnel into the glacier, and storage chambers on either side of it, with a branch track running into the tunnel, to convey the goods. British Columbia salmon and other products could be stored for any length of time, for convenient shipment to eastern markets. Other glaciers could, of course, also be used—possibly one could be found on the Labrador or Greenland shores, not far from trade routes.

The tunnel project involves the construction of a submarine embankment, preferably of clay mixed with rock ballast, to within about 30 feet of the surface of the water, which would allow a sufficient depth for shipping, and afterward excavating the tunnel through the embankment. The material removed for the approaches to the tunnel could be used for the embankment, the width or height of which could be increased, if necessary, by using the material excavated from its interior. In building railway embankments, it is found, that such material will force its way through enormous depths of boggy deposits, and it therefore seems probable that this could also be done in building these tunnel embankments, where a heavy layer of silt is encountered, as on the bottom of the harbor of New York.

The avoidance of blasting operations would greatly reduce the cost of construction, the moderate character of which is shown by the fact that thousands of acres of real estate have been built out into the harbors of San Francisco and Boston. The work would be of precisely the same nature, where the embankments are built above the surface of the water for a short distance from either shore, and the material for the central portion could be distributed by self-dumping scows. These shore sections of the embankment would afford valuable wharfage, and cheapen the cost of the approaches. At the Strait of Canso, N. S., where the water is very deep, and one of the shores considerably elevated, the comparison as to cost, with the usual methods of tunnel construction, would be most favorable. On the elevated shore of the strait, the grade could be greatly modified, as well as the cost of construction, by extending the embankment for a considerable distance above the surface of the water. Either a bridge or an ordinary tunnel at this point is considered a serious engineering problem.

Similar engineering skill would be required in carrying out the proposed plan for the harbor of this city. Bay of Fundy tides are well known for their unusual height, and have a range in this harbor of about 30 feet, leaving the smaller shipping stranded at the docks, when the tide is out, and greatly aggravating the difficulty of providing the larger shipping, to which such methods are dangerous, with adequate wharfage. The entrance channel to the harbor is very narrow, with a small rocky island and breakwater on one side, and about three miles of shallow rock flats on the other, which also extend over a large area of the harbor, and render it worthless to shipping except at high tides.

Beginning at the opposite shore and working out toward the entrance channel, an embankment of clay and rock ballast, say 50 or 100 yards wide, could be constructed at a moderate cost, and when completed would only leave an outlet at the entrance channel equal in capacity to the volume of the river water entering the harbor, which would then maintain the high water level. A lock would be required near the outlet to accommodate ships entering the harbor at low tide, but of course the outlet could be used at all other times. Some engineering difficulties might be encountered during the course of construction, but they could doubtless all be overcome. By providing drawbridges at the lock and outlet, traffic across the embankment could be accommodated, but such equipment would be of more value at a point farther up the harbor, where a ferry service to Carlton is established, across a narrow arm (the river channel) of the harbor, which could be crossed in the same way, by a bridge and embankment, through which only a channel (not graduated) would be necessary. The embankment at the entrance of the harbor could, of course, be abandoned, and the whole equipment located here, but the capacity of the harbor would be greatly reduced, and shipping still exposed to the dangers of the long narrow entrance channel. This plan of harbor improvement, unlike some others proposed, would not complicate the sewage problem, on interference with the passage of silt and rubbish, brought down by the river.

Embankments of this description could be built out from the shores of rivers obstructed by shoals and rapids, where the banks have sufficient elevation to retain the water, making them into a succession of elongated lakes, which could be entered, in both directions, by means of locks and graduated outlets, as previously described. Provision would have to be made for floods, but this could be done by paving portions of the embankments with stone or brick, over which the water would flow at the proper elevation. The cost would surely be far less than would be necessitated by a system of canals. An embankment subjected to somewhat similar conditions has long been in use at Holyhead, Wales, over which the Chester and Holyhead railway passes. It is three-fourths of a mile in length, with a gap at the center through which the tide rushes with great violence.

One of the best opportunities for putting this project into successful operation is afforded by the St. Lawrence and Ottawa rivers, and a small tributary of the latter, almost completing the connection with Lake Nipissing and thence to Georgian Bay by the French River. Only about twenty-five miles of canal would have to be excavated, and if no greater obstructions stand in the way, the opening of this route to large vessels would prove an inestimable boon to Canadian and Western commerce. W. F. Cleveland.

Royal Hotel, St. John, N. B., Canada.

Oil Well Fires in Texas.

To the Editor of the Scientific American:

We note with pleasure the extensive space you have devoted in your issue of January 10 to the Southwestern oil fields and to the fires which have occurred in these fields in the last six or seven months. It is hard for people in the East to realize the entire significance of this great oil belt, extending across Texas and Louisiana, which has been tapped in the last two years at a half-dozen places. We believe the Texas and Louisiana oil fields are worthy of more attention by the Eastern papers in the way of legitimate treatment, such as you have given the subject in your recent issue.

We regret, however, that your correspondent has misstated the facts in several particulars, and we take the liberty of suggesting that you make a correction of these mistakes, if this is consistent with your editorial policy.

To begin with: The statement that one of the largest wells in the Jennings region caught fire and blazed for several weeks, is incorrect. This well was ignited from an oil tank which was set on fire by a stroke of lightning, July 15, and burned continuously until July 21—about six days. It was extinguished in one half minute by the use of steam and water. The well in question is the property of Heywood Brothers, and after the fire it was put into service and has yielded more than 30,000 barrels of oil a month, producing a net revenue exceeding $7,600 a month.

Regarding the Spindle Top fire, your correspondent states that one of the fires destroyed property covering ten acres of the Hogg-Swayne tract and raged for two weeks. He states that this fire occurred in September, and that at one time fifty wells were on fire and that twenty workmen lost their lives before they had time to escape. He probably refers to the first fire on Spindle Top Hill, which occurred in September, and was confined to the Keith-Ward subdivision and a portion of the Higgins tract. Only one well burned continuously in this fire, although ten or twelve were ignited at intervals, but were extinguished without difficulty. This fire lasted three days. There was no loss of life in this fire. In October a fire occurred in the Hogg-Swayne tract, destroying about fifty derricks, and in this fire one workman was burned so badly that he died. In this case the fire lasted only eight hours.

The statement made by your correspondent that water has proved ineffective in extinguishing the Southwestern oil fires is also incorrect. In the Beaumont fires, water was relied upon, as it was at Jennings, and combined with steam, it had the desired effect. It must be remembered that when a stream of water is turned upon a red-hot pipe or tank, it is immediately converted into steam, and this has the same effect as if steam were sprayed upon the fire from pipes.

We trust that you will make these corrections, because we believe they are essential facts and deserve to be properly stated. Considerable prejudice has been raised against the Texas oil fields on account of the fires, and sensational newspapers have seized upon every possible excuse for printing glaring accounts of the few fires that have occurred. We believe that the loss of life and property through fires has been remarkably small.

Holland S. Reavis.

Jennings, La., January 13, 1903.

Natural Growth of Mushrooms in a Circle.

To the Editor of the Scientific American:

In Scientific American of January 3 an article accounting for mushrooms growing in the form of a ring on account of the exhaustion of the organic matter is misleading and incorrect.

Mushrooms do not come from seed or spores directly. The spores produce mycelium under favorable conditions; and this mycelium will produce mushrooms if the conditions are favorable. Otherwise mycelium will reproduce mycelium, and if conditions remain unfavorable during the first two generations, then there are seldom, if ever, any mushrooms produced until the sixth or seventh generation, when some mushrooms may develop, otherwise the ring and time are extended to about ten or eleven generations. If Prof. F. S. Lamar will take some soil that was inside the ring, or soil upon which mushrooms have grown the previous season, and will plant some first generation mycelium, making the conditions favorable, he will find that it will produce mushrooms and prove his theory wrong. Mushrooms are not particular about the kind of soil they grow in, organic matter sufficient is produced annually, but they are very dependent upon suitable moisture and temperature. Mycelium is more dependent upon the kind of organic matter and less upon moisture and temperature. Fairy rings of fungous growth can be produced by design by controlling the conditions, and thus prove the correctness of my theory.

A. B. Leckenby.

Eastern Oregon Experiment Station, Union, Oregon, January 28, 1903.

A Tidal Wave in the Pacific.

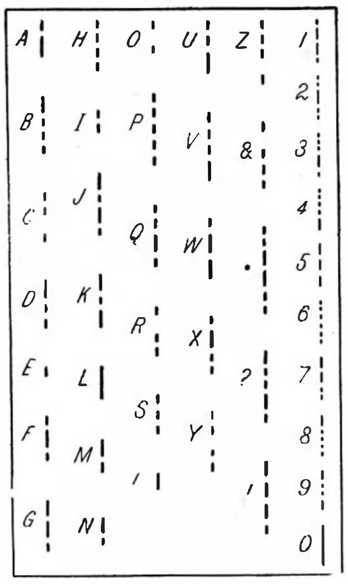
On February 9 the Low Islands in the South Sea suffered much damage from a tidal wave. Of the hundreds of islands to be found in the Pacific, many of them located in lagoons surrounded by coral reefs, the Low Islands are perhaps the most exposed. The islands take their name from the peculiar classification of the inhabitants of the South Sea. Islands are divided into high and low. Thus it comes that the Paumotu Islands are often named on the maps the Low Islands. Like many of the South Sea islands, the Paumotu or Low Islands are of coral formation, rising not more than 20 or 30 feet above the level of the sea, and therefore particularly exposed to tidal waves. The High Islands, on the other hand, are of volcanic origin, and sometimes project their heads to a height of 8,000 feet. In the Hawaiian group still higher elevations are attained. The Paumotu Islands have an area of about 400,000 square miles, which is about half as large again as the State of Texas. Fortunately, in view of the recent disaster, their population is small. Had the calamity occurred in the High Islands, which are more thickly populated, the fatalities would perhaps have been appalling.

A Scarlet Fever Serum.

The announcement was made at Berlin, February 2, that a scarlet fever serum had been discovered which seemed full of medical promise. Experiments were said to have been conducted by Dr. Aronson, which were quite successful. The result of these experiments was announced by no less a person than Prof. Baginsky, the head of Emperor and Empress Frederick Children's Hospital of Berlin. He is, therefore, in a measure responsible for the announcement of the therapeutic value of the Aronson serum.

The Current Supplement.

The current Supplement, No. 1416, opens with a most elaborately illustrated article on "Electric Traction at Cape Town." Henry R. Lordly discusses exhaustively the subject of anti-friction bearings, illustrating his text by many telling diagrams. Two articles on calculating machines, one on a mechanical cashier, and the other on an automatic adder, subtractor, divider, and multiplier, should be read with interest. The English correspondent of the Scientific American begins his account of the Water Supply of London. C. F. Saylor presents in an interesting article the progress of the beet-sugar industry in the United States. "The Universe as an Organism" is the title of a semi-philosophical paper which contains much food for reflection. Prof. Bedell, who recently announced a method of using one wire for transmitting alternating and direct currents, discusses the subject in a popular paper.



HOW THE BOARD IS WIRED FOR THE MORSE ALPHABET.

RECORDING TELEGRAPH FOR AMATEURS.

BY THE LATE GEORGE M. HOPKINS.

If the question of utility controls one in making and trying a piece of apparatus, it is useless to expect to realize anything in the way of profit from the recording telegraph illustrated and described; but a few interested amateurs can co-operate, and with a wire and transmitter for each can secure a practical knowledge of the workings of some of the large telegraph systems and of some of the applications of electricity, which could not be secured in any other way. The expense would be slight, when there is a joining of amateurs for one purpose.

It is assumed that an ordinary sounder is available for the central office recorder, and that every subscriber will furnish a transmitter, a wire to communicate with the central office recorder, and battery sufficient to operate one branch of the central office system.

In making the central office recorder, a common sounder is pressed into service. It is provided with a stylus-holder which is clamped to the free end of the armature lever. The stylus is a piece of steel wire 1-16 inch in diameter and 1 inch long, with a rounded and hardened point. It is clamped in place by a set screw.

Under the free end of the armature lever is journaled an arbor, carrying a wooden roller having a V-shaped peripheral groove at the center, exactly under the stylus; so that when a paper strip passes over the roller, the stylus can make a slight depression in the paper, when the sounder magnet is actuated.

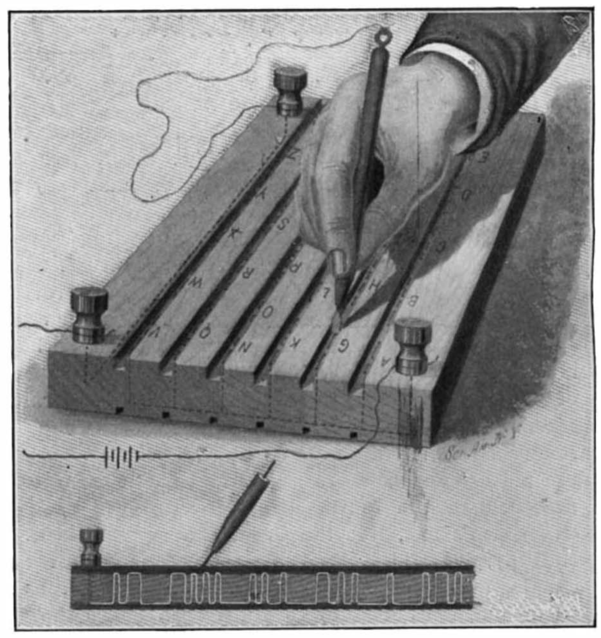
The principal features of this telegraph are a simple transmitter for giving fixed calls, like a call box, and the mechanism for carrying the paper tape over the grooved spool and under the stylus. The roll of tape as purchased from the dealer is carried on a wooden reel, supported by a standard at the rear of the sounder. Between two standards in front of the sounder are journaled two rollers, *a b*. The roller *a* is flanged and provided on its periphery with three or four rubber bands, to give it frictional contact with the paper tape. The lower roller *b* is covered with a piece of rubber tube and the shaft of this roller carries a small governor *c*, for regulating the speed of the tape. The tape extends over the roller *b*, thence downward under the flanged roller *d*, then upward to a fastener. The roller *d* is provided with a weight which actuates the mechanism.

It will thus be seen that the paper tape is carried through the machine by the action of the weighted roller *d*, and its motion is regulated by the governor *c*. The governor *c* consists of a slotted hub *f*, links *g g*, pivoted in the slots of the hub, a slotted sliding block *h*, placed loosely on the shaft of the roller *b*, weighted arms *i i* pivoted in slots in the block *h*, and pivotally connected to the outer ends of the links *g g*, and a light spring, *j*, tending to draw the weighted arms *i i* toward each other. The block *h* is provided with a leather washer *l*, which produces necessary frictional contact with the standard, when the weighted arms are thrown out by centrifugal action. The tape reel is provided with a slight spring for checking its motion when the paper feed stops. In the side of the block which carries the stylus is inserted a small stud, in which is clamped a wire *m*, having its free end near the side of the roller *a*, flattened and turned up at right angles. The flattened end of this wire *m* lies in the path of a small pin projecting from the roller *a*, so that whenever the armature lever is drawn down by the magnet, the pin is released, and the roller *a* is allowed to turn, but when no current passes the magnet, the armature lever rises and brings the flattened end of the wire *m* into the path of the small pin, and stops the movement of the roller *a*, and consequently arrests the progress of the paper, until the pin is released by another action of the armature lever. Binding posts placed at the rear of the sounder are connected with the magnet electrically in the usual way. To transmit a signal over a line connected with this instrument, it is not necessary to understand the telegraph alphabet, nor to know anything in regard to telegraphy. The signals are pre-arranged, so that the operation of sending is purely mechanical.

The signal board here represented in detail, was invented and patented years ago by William Hadden, but the patent has long expired. This simple device consists of a board, a few inches wide, and perhaps twice the length, depending on the number and length of the messages sent. The board here shown is 4½ inches wide, 7 inches long, and ¾ inch thick, with as many longitudinal grooves formed in it, as there are signals to be given. The signal board must be of very hard wood, and the dots and dashes of the signals are formed by sewing No. 30 plain copper wire through holes extending through the board, from the grooves in front to the grooves in the rear. As the signal transmitter is at present constructed, the copper wire sewed through the first set of holes represents the letters of the Morse alphabet from *A* to *F*, with a dash between each letter. The sewing in the second groove represents the letters from *G* to *J*. The sewing in the third groove represents the letters from *K* to *M*, and so on. All of the wires forming these letters are connected together at the top of the board, by a wire on the back, which is in electrical connection with the binding post seen to the right in our view of the signal apparatus. The binding post at the opposite edge of the board is connected on the back of the board with a third binding post, at the lower end of the board. The third binding post is connected by a flexible cord with a wire, having a flattened end, and provided with a wooden handle. Sending a signal consists simply in drawing the flattened end of the wire with a uniform speed down one of the grooves. The first two binding posts, being connected with the binding posts of the recording instrument and with a battery, when a signal is sent, the recorder is released automatically, and the detent is constantly withdrawn from the pin in the roller, so long as the signal is being sent, and the message is thus recorded. When the signaling stops, the recorder is stopped by the action of the detent.

Several transmitters may be connected with the recorder, and one wire in each case may be dispensed with, by grounding the other at each end.

The recorder will run long enough to record a long signal or several short ones, with one raising of the weight carried by the paper tape.



VIEW OF THE TRANSMITTING APPARATUS.

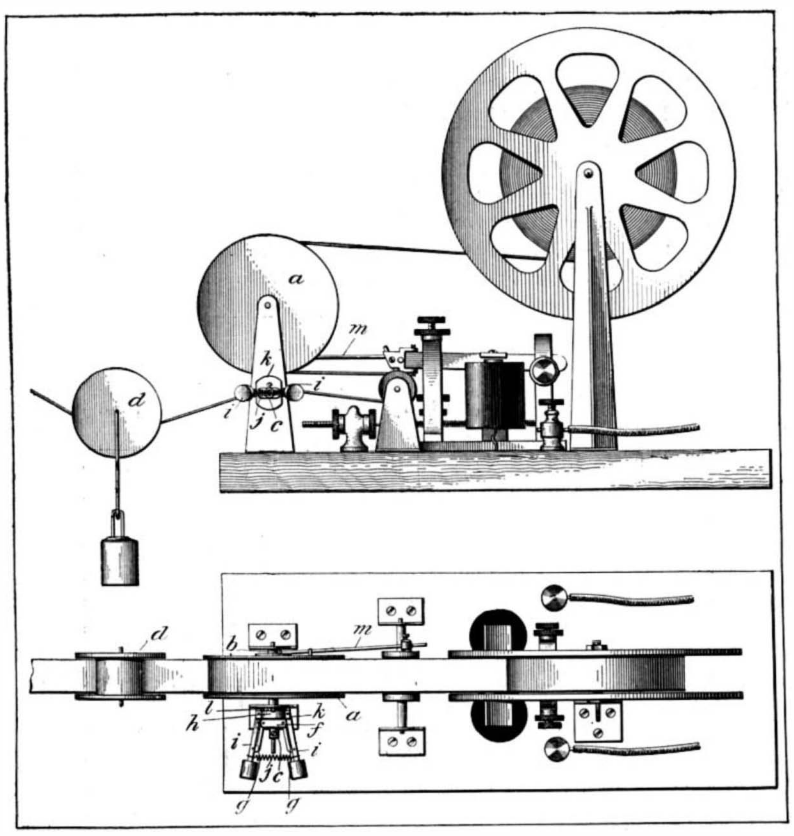
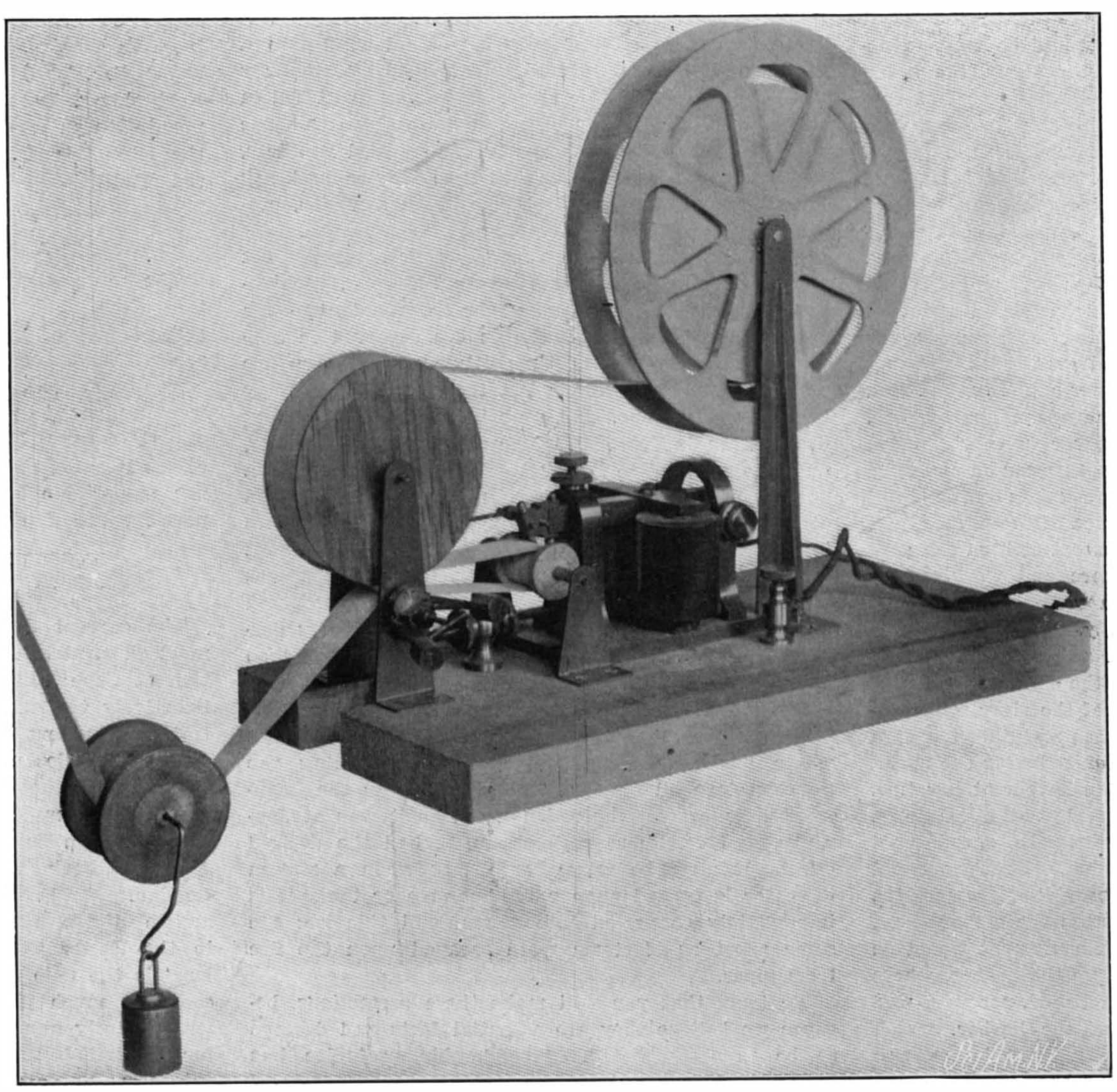


DIAGRAM OF THE HOPKINS RECEIVER.



THE RECEIVING INSTRUMENT OF THE HOPKINS RECORDING TELEGRAPH.

The motive power used in the manufacturing establishments of the United States in 1900, according to the census report, aggregated 11,300,081 as compared with 5,954,655 in 1890, 3,410,837 in 1880, and 2,346,142 in 1870. During the census year steam power represented 77.4 per cent, water wheels 15.33 per cent, horse power 1.3 per cent and other forms of mechanical power one-fifth of one per cent. New York leads the States in the use of water power, having 368,456 horse power derived from that source.

VENOMOUS SNAKES.—II.

BY RANDOLPH I. GEARE.

The American species of Elapids known to be poisonous are the Harlequin Snake, or Bead Snake (*Elaps fulvus*), and the Sonoran Coral Snake (*Elaps euryxanthus*).

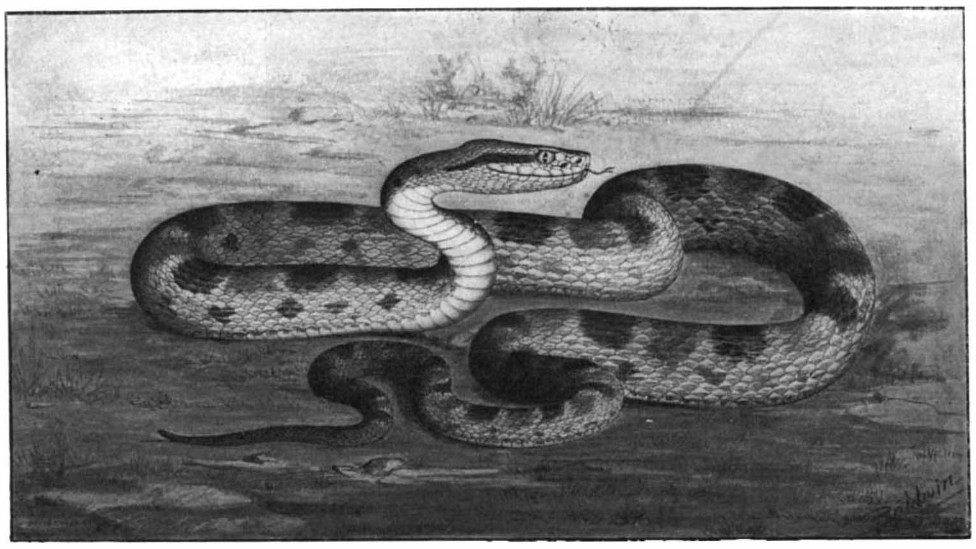
The Harlequin Snake is found in Virginia, Georgia, Florida, Alabama, North and South Carolina, and Mississippi, and north along the Mississippi, Missouri, and Ohio Rivers. In southern Texas, too, it occurs in many localities. This snake is said to be very gentle and mild in disposition. Its favorite haunt is supposed to be underground in sweet potato fields, where it is frequently unearthed by laborers in harvesting. Its food consists chiefly of other snakes and various kinds of reptiles. One specimen found had swallowed another snake as long as itself; while, in addition, it had a garter snake about half digested. The Harlequin Snake is described as having a ground color of red with numerous black rings and intermediate spaces of yellow. The tail is alternately black and yellow.

A rather curious variety of rattlesnake is the *Crotalus cerastes*, which, as its name indicates, is distinguished by a horn over each eye. Horned rattlesnakes are most venomous.

A rattlesnake which goes by the Indian name of Massasauga is one of the small but very venomous rattlesnakes which inhabit the prairies in the western United States and territories. The most prominent of these rattlers is the *Crotalaphorus tergeminus* (*Sistrurus catenatus*). One of the characteristics of the Massasauga is the top of the head, which is covered with regular plates just as in harmless serpents, and not with scales as in most rattlesnakes. The pit between the eyes and the nose, however, is present as in all *Crotalidæ*. The Massasauga snakes are of dark, blotched coloration, and are rarely more than one or two feet long. Sometimes they are called sidewipers and sideliners from their habit of wriggling sidewise.

A few words on the structure of a rattlesnake's rattle may not be without interest. Briefly described, the rattle consists of a number of hollow, horny rings, somewhat like quill in substance, and interlocked with one another, while they are so elastic as to permit of a considerable amount of motion between them. These rings are not indicative of age, as has been supposed, since in some years several appear, while in others only one ring may be developed. Though there is a great variety of color in rattlesnakes, this feature can in most cases be used as a means of determining the species, other distinctive characteristics being found in the arrangement of the shields covering the fore part of the head.

The dread which even the bare thought of receiving a charge of the deadly venom inspires, is fortunately somewhat diminished by the well-known fact that this snake always "rattles" before striking. There has been a great deal written as to the reasons which cause them to "sound the alarm." The old theory was that the "rattling" was intended to warn the prey of their approach. This, however, seems altogether too charitable a view to take, for it is quite natural to supose that the snake would keep as quiet as possible when lying in wait for food, lest it should frighten away the approaching animals upon which it supposedly depends for its sustenance. Another view, and a more plausible one, is that, as the cobra expands its frill and the puff-adder swells and hisses, so the rattlesnake sounds its rattle for the purpose of alarming any antagonist—be it man, beast, or bird—who may design an attack. Thus it becomes a weapon of defense—perhaps an expression of fear. The snake, not being endowed with human thought, would hardly realize that in making itself known to its enemies, it was betraying itself, while by remaining quiet, its presence might be overlooked. Another common belief is that the rattle is sounded as a means of bringing to its assistance other snakes of its own kind. Prof. Samuel Aughey, in an article on the "Rattle of the Rattlesnake," confirms this belief. He says he once saw a number of hogs attacking a rattlesnake. The snake at once commenced rattling, and three other snakes almost immediately came to the rescue, but the hogs were victorious, and all the snakes were killed. Some authorities, who have made careful observations, believe that the true function of the rattle is to bring the sexes together for mating, while still others affirm that its principal use is to frighten and paralyze the victim into submission, thus acting as a kind of "charm." There is yet one more theory to account for the use of the rattle, namely, to ward off disturbers that cannot serve as food, and thus prevent a useless expenditure of venom!—surely fixing this snake as a strict economist, if true.



THE WEST INDIAN FER DE-LANCE.

These theories may all be partly correct. The phenomenon may perhaps be most easily explained by accepting and applying Herbert Spencer's suggestion regarding the wagging of a dog's tail, i. e., that it is an escape of nervous force which is restrained from any other mode of expression at the moment.

No species of rattlesnake occurs in any of the West Indian islands proper. Several species are found in the United States, as pointed out, and indeed there are but few localities here where this snake is not present, or rather where it was not found before it was exterminated. Still, the area inhabited by more than one species of *Crotalus* is comparatively limited.

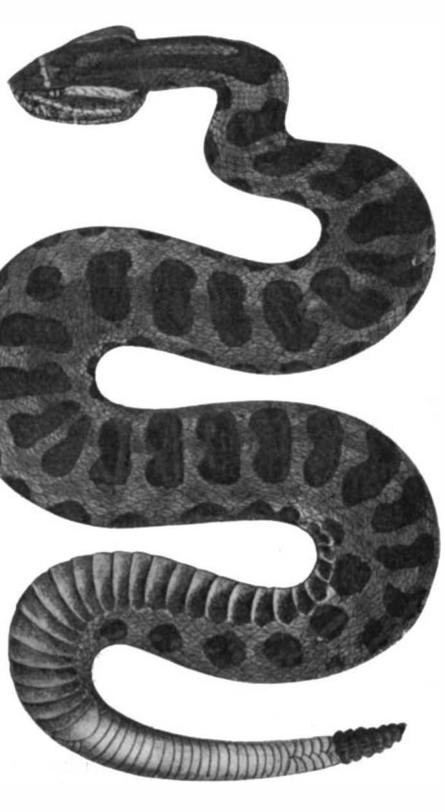
It may not be out of place to tell here something of the Fer-de-Lance, the deadly snake of Martinique, which is said to have been all but exterminated by the recent volcanic eruptions. This serpent may be regarded as a yellow viper of the family *Crotalidæ*, designated zoologically by the term *Craspedocephalus* (or *Bothrops*) *lanceolatus*. The Fer-de-Lance is from 5 to 7 feet long, and is said to be capable of making considerable springs when in pursuit of prey or of some object by which it has been irritated. Its bite is fatal, the only antidote seeming to be, as in the case of bites of other venomous snakes, whisky or other ardent spirits. The serpent infests sugar plantations in the West Indies, and is dreaded alike by man and beast. The tail ends in a horny spine which scrapes harshly against objects, but does not rattle. How deadly is the Fer-de-Lance may be gathered from the description of a writer in Harper's Magazine: "If by some rare chance you encounter in the island [of Martinique] a person who has lost an arm or a leg, you can be almost certain you are looking at a victim of the Fer-de-Lance—the serpent whose venom putrefies living tissue."

(To be continued.)

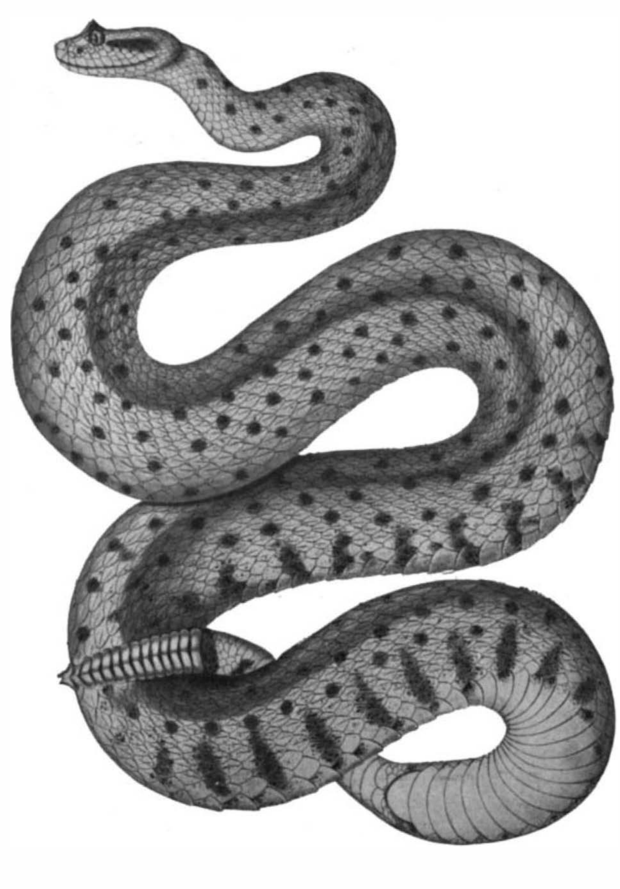
Protecting the Sponges.

The use of the "skafander" has been abolished by Samos, Crete, Cyprus, Tunis, and Egypt. Now Turkey and Greece have followed suit. The skafander is a device by which a diver can remain under water for about an hour. He is thus enabled to comb the bottom of the sea with a thoroughness that has almost exterminated sponges in many parts. The employment is its own punishment; for the diver usually dies of palsy of the lower extremities. The law now steps in to assist nature in protecting the sponges. In addition to the skafander, the natives resort to harpooning, primitive diving apparatus, and dredging.

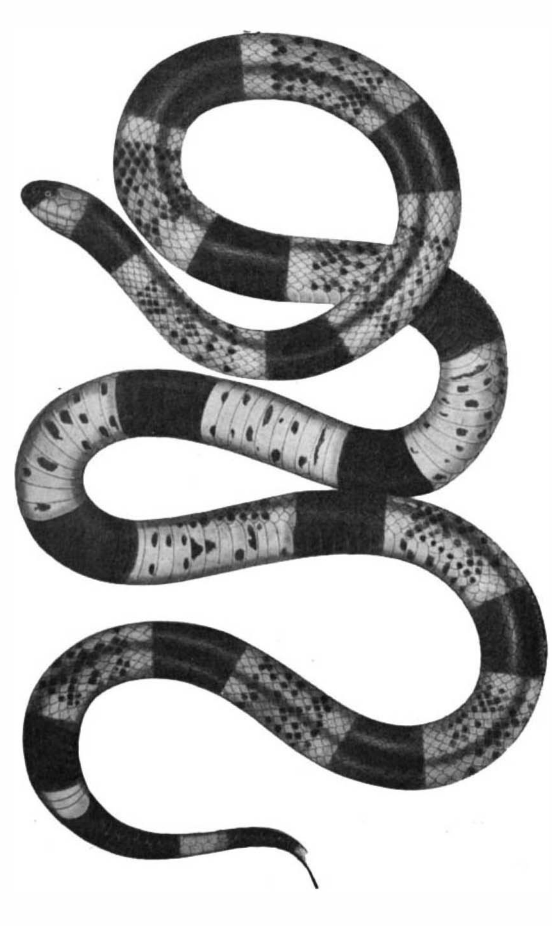
The frequency with which old pipes made of clay, wood, and metal have been found in England, Ireland, Germany, Switzerland and France, has led archæologists to the belief that the ancients may have smoked. The belief receives some color from passages in ancient authors. Herodotus remarks that the inhabitants of the Aroxes Islands, supposed to be the modern Volga, "were wont to throw piles of fruit on a fire and then to inhale the vapor, with the result that they became as drunk as ever the Greeks became after drinking wine, and the more fruit they threw on the fire the more drunk they became." Pomponius Mela talks in a similar strain of certain Thracian tribes. Pliny asserts that the vapor of plants was used to cure diseases, and says that in some instances it was even inhaled through a tube.



MASSASAUGA (AFTER HOLBROOK).



HORNED RATTLESNAKE (CROTALUS CERASTES).



HARLEQUIN SNAKE.

NEW YORK'S STEEL ROADWAY.

The laying of a track of broad, flat, steel rails on Murray Street, between Broadway and Church Street, which was accomplished the middle of last December, was the second step in the opening of a new era of transportation in this country. The first step was the introduction of automobiles; the second is the building of good roads for them—roads that shall be suitable for horse-drawn vehicles as well.

The steel road, strange as it may seem, was first tried in unprogressive Spain, where a section of it two miles long has undergone the abuses of the heaviest kind of wagon traffic for over ten years, and yet has stood the test well. At the end of seven years, the average cost per year of maintaining the sides and center of the roadway was found to be but $380, as against $5,470 per annum paid to maintain the flint stone paving or surfacing previously used. The wear of the rails themselves was but 0.1 mm., or 0.003 inch a year.

Gen. Roy Stone was the first to see the possibilities of this form of road and to advocate its use in this country, which he did most urgently a year ago, in an address before the Automobile Club of America. President Charles M. Schwab, of the United States Steel Corporation, had some rails rolled after Gen. Stone's designs, and presented them to the Automobile Club, in order that it might lay and test them. It was thought that Murray Street offered the severest testing ground, on account of the heavy trucking through that thoroughfare. Consequently, that was the street chosen in which to make the first test. The rails have been in use two months now, and teamsters driving through Murray Street have learned the advantage in using them. Our illustration gives a good idea of the appearance of the street at present.

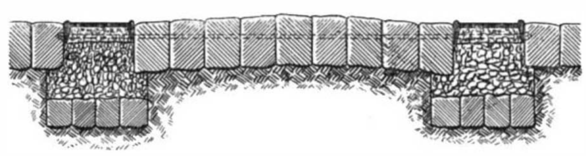
A glance at the cross-sectional cut will show the reader how the roadbed is prepared for laying the rails. Two 18 x 18-inch trenches are dug and filled with 1½-inch broken stone laid over a layer of old paving stones, and top-dressed with 3 inches of fine gravel. The rails are laid on this and fastened together at their ends with fish plates on the sides and bottom, while ¾-inch tie rods at intervals keep them parallel and properly spaced. In building a country road, the earth is graded up to the rail on each side and filled in slightly higher in the center, so as to give the general contour shown in the cross-section.

The rails used in Murray Street are 40 feet long and 1 foot wide, with flanges 3 inches wide on the under side and ⅝ inch wide on the top. The rail is ⅝-inch thick near the flanges, and a trifle thicker in the center. The slight flange on each side of the top of the rail tends to keep a wagon wheel from running off with any slight side-pull, while it can nevertheless easily surmount the flange when the driver wishes to run on or off the track. The rails are laid with the alternate joints on opposite sides, similar to those of a railroad track. The distance from center to center is 5 feet, 6 inches. The weight of the rails is 25 pounds to the foot, or 132 tons per mile, and the estimated cost of a mile of track, including laying, is $4,000. Gen. Stone believes, however, that on country roads lighter and narrower rails weighing but 100 tons per mile can be used, and, with steel at $18 per ton, as it is in times of depression, this figure can be cut in half. When once built, a road of this type will last a generation if the earthen part of it is kept in repair at slight expense.

Comparative tractive tests have demonstrated that the power required to haul a wagon on a steel roadway is less than one-fourth that needed on the ordinary stone road. According to the report of a Pittsburg, Pa., engineer, Mr. F. Melberger, who made some tests with a 1,350-pound wagon on a steel road, the average drawbar pull per ton was but 3.23 pounds, as against 41 pounds per ton on macadam and from 75 to 102 pounds per ton on hard earth roads, as demonstrated by previous experiments made in Atlanta, Ga., under similar conditions. This means that 12 times as much power is required on macadam as on steel, and from 23 to 31 times as much on dirt roads. Experiments also show that the tractive force required on steel is considerably less than on asphalt.

These figures, coupled with those secured by the government as to the cost per ton-mile for haulage on country roads, viz., 25 cents, as against 8 cents per ton-mile in Europe, only go to show how wasteful our present roads are. Of the $90,000,000 expended annually for road transportation of farm products, etc., fully two-thirds is chargeable to poor roads.

With such facts as these before it, it is to be hoped that Congress will have the wisdom to pass the Brownlow bill appropriating $50,000,000 for assisting in building good roads, which, according to the provisions of the bill, may be built with steel rails if desired.



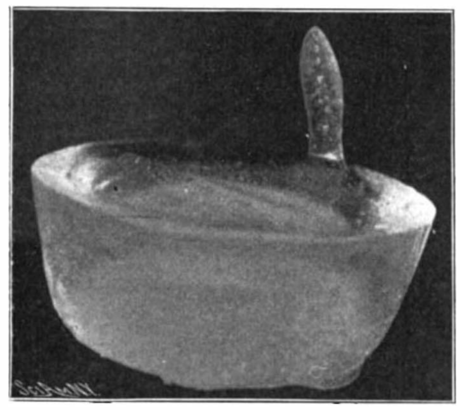
CROSS-SECTION OF STEEL ROADWAY.

APPEARANCE OF STEEL ROADWAY IN MURRAY STREET, NEW YORK.

A CURIOUS CASE OF REGELATION.

Mr. Howard, of Hillsboro, Ohio, sends us a photograph of a lump of ice whose genesis is somewhat puzzling. His account of the affair is as follows:

"During a cold spell several evenings ago, I left one night a graniteware cup full of hydrant water on the floor of a wooden outhouse. There was nothing in the room to disturb it. In the morning the water was frozen, and I was greatly surprised to see a spur two inches long projecting from the block of ice on one side. The cup is about four inches across."



A CURIOUS ICE FORMATION.

Perhaps some of our readers may be able to point out some explanation; meanwhile the following theory has been suggested: The cause of this phenomenon may be somewhat as follows: The water was rapidly cooled, and a layer of ice formed at first on the surface. Then, owing probably to an unusually rapid fall in the temperature and to the fact that the granite basin is a better conductor of heat than the ice and water, a crust of ice formed lining the granite cup, and inclosing, together with the ice on the free surface, a quantity of unfrozen water in the cavity so formed. Any further freezing of water contained in this cavity must now create a pressure there, since the ice formed occupies more space than the water. But as the pressure increases the freezing point falls, as is well known, so that after a while there would be contained within the cavity of the block of ice a quantity of water at a temperature below 32 deg. F., that is to say, below the normal freezing point. A further fall of the temperature caused the formation of some more ice, and, consequently, a further increase in the pressure within the block, until at last this pressure became sufficient to burst the ice, and the water was squirted out in a jet. At the same time the pressure was relieved, and thus the freezing point of the water rose to its normal value, so that the water of the jet, being some degrees below this point, immediately froze as it stood.

A somewhat similar occurrence is described in La Nature as having been observed about the middle of December last. D. Crispo, director of the government laboratories at Antwerp, writes that some of the specimens of water in his laboratory froze in the bottles containing them, and one of the bottles presented a most curious appearance, the ice protruding from its neck in a long, smooth worm, capped by the cork, which was forced out. Mr. Crispo thinks that in this case the ice was gradually squeezed out by the increasing pressure in the bottle, behaving like a viscid liquid in consequence of fusion under pressure and subsequent regelation. He does not think it likely that the water was squirted out suddenly. But it must be noted that the case recorded by our correspondent offers something different from this. The ice in the bottle might be squeezed through the unyielding glass nozzle, but if we suppose that the spur on the block of ice of our illustration was gradually forced through a hole in the block we are faced by the difficulty that here the aperture itself, having edges of ice and not of hard glass, would itself be melted by the pressure and would widen out, so that no spur could be formed.

We should be interested to hear the views of some of our readers on this matter.

THE ORANGE IN NORTHERN CALIFORNIA.

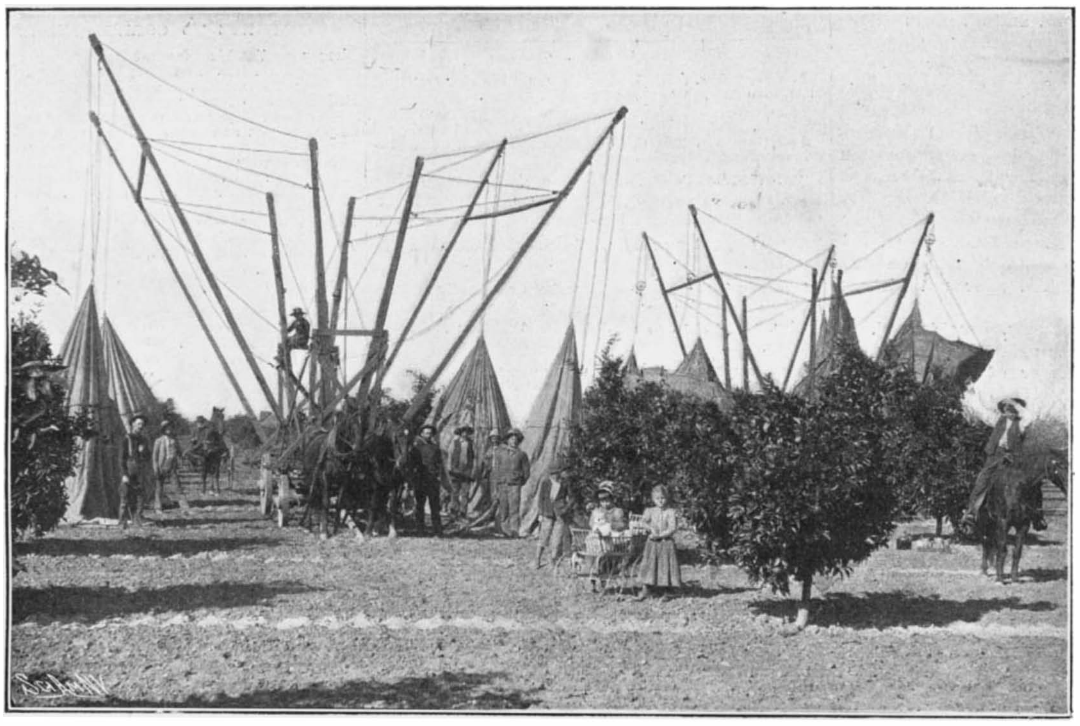
BY ENOS BROWN.

Planting of the first orange tree in the Sacramento Valley was coincident, almost, with its permanent occupation by Americans. Very few of the early miners dreamed of more than a temporary settlement in the land of gold. They had but one purpose—the sudden acquisition of wealth and a return to their distant homes to enjoy it. To most persons the character and resources of the new country were not even conjectured. Geographical science, fifty-four years ago, probably knew less about California than is now universally known about the interior of Africa. A few years' residence by the new settlers, however, was sufficient to demonstrate the transcendent charm of the climate and the exuberant fertility of the soil, and to convince them of the wonderful agricultural resources of the new land.

Cultivation of the orange as a commercial proposition in these northerly regions was one of the results of the sequestration of placer mining under the anti-debris law—the golden fruit to supply resources that had hitherto been drawn from golden sands. Progress has been rapid. In 1893, but four cars were shipped from the Sacramento Valley. In 1896, shipments had increased to 81 cars, but, in 1901, the total cars shipped out numbered 2,341, a number which fairly entitles northern California to more than a respectable position in the orange fruit trade.

The city of Oroville, Butte County, may be fairly regarded as the center of orange cultivation in the Sacramento Valley. It is 450 miles north of Los Angeles, and in about the latitude of Philadelphia. Soil and climatic conditions are especially favorable here, and the orange tree reaches its fullest proportions and the fruit its most perfect flavor. The mean annual temperature here, as in all the orange growing counties of the valley, averages but four-tenths of a degree below that of Los Angeles. So mild is the climate that frost never damages the orange groves of the locality, neither do pests, which southern orange growers have ceaselessly to combat, ever prove a serious menace. The orange growers of the Sacramento Valley boast that their fruit ripens two months earlier than in southern California, which lies 7 degrees farther south. By the time the northern orange crop is gathered, shipped, and sold, the southern orchardist is beginning to pick his fruit.

Throughout the Sacramento and San Joaquin valleys plantations of orange trees are located on the bluffs or foothills, in preference to valleys, which are more liable to be reached by frost. The soil preferred is that of a deep, gravelly, ferruginous, and porous nature. Though thousands of young trees are planted yearly, additional to those in full bearing, the limit of



ERECTING TENTS OVER ORANGE TREES BY MACHINERY.

acreage is very far from being reached in California. There is no danger from an oversupply of fruit. The market seems to be boundless.

The methods pursued by the orange cultivators of Butte County are such as any one, even though not experienced in the business, can easily acquire. There are no secrets about it. The first requirement is in land selection, about which there need be no difficulty, the only choice being the distance from the shipping point; the nearer the land to this, the more expensive it is naturally. Irrigation is an absolute necessity, owing to the scant summer rains. Water is piped to the lands under a common ditch.

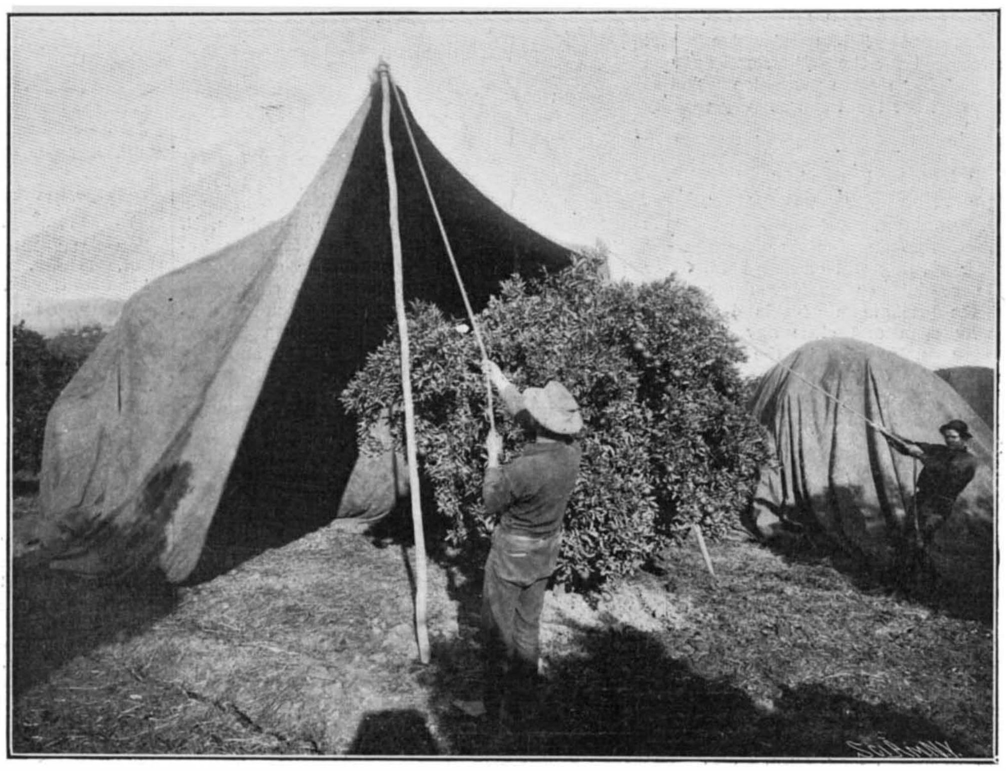
Preparing lands for orange cultivation involves repeated plowings and harrowings both ways, in order to pulverize the soil and extirpate vegetation. The ground should be leveled and hollows filled up. With a gentle slope, a regular flow of irrigating water is assured. Land is plowed to a depth of 7 inches. Fertilizing with stable manure and nitrates is customary. Orange growing exhausts the soil in time, and it is necessary to restore its diminished strength.

Trees are planted 25 feet apart or 70 to the acre. Year old seedlings are procured from the nurseries. In three years these seedlings attain a strong growth, the trunk measuring in diameter about 2½ inches. The trees, now ready to bud, are pruned. This is done by cutting off all upper branches, leaving nothing but the forked stump, which is from 3 to 4 feet high. Two incisions like the letter T are made in the bark, into which the new bud is inserted. A string tied around the cut keeps the opening closed and the new bud soon begins to show signs of growth. About two buds are inserted in each trunk, all superfluous growth is checked, and every atom of nourishment is directed toward the development of the new grafts. During budding the stumps are covered with sacking to prevent too rapid evaporation and to afford protection from the sun's heat. September and October are the budding months. From the time of planting the first seedlings the land is cultivated without much cessation. February, March and April are the months when the ground is plowed and cross-plowed. Afterward it is harrowed each way to within three feet of the trunks. Under the trees the soil is cultivated by gangs of men. February and March is the time for pruning. All low and superfluous growth is then cut down. Water is generally conducted to the groves in pipes placed below the surface with openings at convenient places. Ditches are run between the rows and three feet distant from the trees, three ditches between each row. Water is supplied at least once each month and for twenty-four hours at a time. After each irrigation a harrow is run over the ground and the temporary ditches leveled. May, June, July, August, September, and October are devoted to cultivation and general oversight. In November the fruit begins to mature and all else is dropped in order to gather the crop. The gathering season is in full operation by the middle of the month, when the labor of every man, woman and child is utilized for picking, packing and shipping the ripe fruit. This essential matter being concluded, the season is over and the orchardist is permitted a rest.

Three years after budding or six from planting the seedlings the trees begin to bear. The first crop is 280 oranges, the second averages 420, increasing in number each successive year, provided that cultivation and care is never neglected.

In scientifically conducted plantations the soil is kept absolutely free of extraneous vegetation, every atom of nourishment being required by the tree. The orange tree is a rapid grower and yields prolifically when properly attended to. Neglect is promptly indicated by shrinking and discolored foliage and diminutive fruit. In health it displays every evidence of thrift. When properly cultivated, the orange is one of the most beautiful of trees.

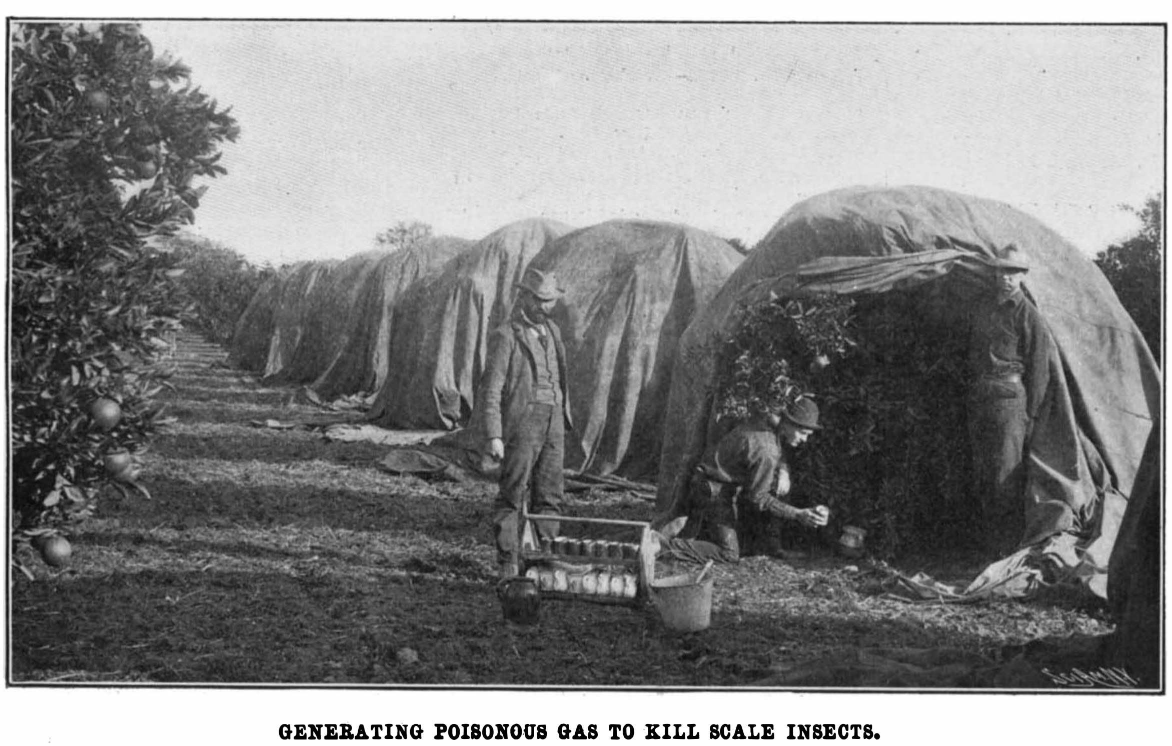
Co-operation among neighboring orchardists provides for handling and shipping the ripe fruit. Uniformity of grade and other advantages are thus secured. A central packing house receives from the orchards. The highest grade is 80 to the box, diminishing to 96, 112, 126, 140, 150, 176 and 200 to a package. Packing and papering is done by ordinary help, requiring no especial skill. The grader is a simple contrivance with a large hopper into which fruit of all sizes is dumped, the sizes being separated in passing down the incline,



SETTING UP TENTS BY HAND TO PROTECT THE ORANGE TREES.

each passing into its proper opening. The oranges cultivated are the Washington navel and Tangarines. The amount of help required in the orchard varies with the seasons. In picking time the number of hands is greatly increased, as it is during the season of pruning. Ordinarily one man to thirty-five acres is the rule.

The cost of starting an orange orchard in the Oroville district, land at from $40 to $75 an acre, has been estimated as follows: Plowing, harrowing both ways, $60 an acre; digging holes to set out trees, $40; seedlings (80 to one acre), $48; cooler for irrigating, $5; labor, per acre, $5; or a total of $108, exclusive of the cost of the land. Second year the expense per acre is estimated at $25.50; third year $20.50, and fourth year $23.80, fifth year $26.50, or a total for five years of $204.30. Ordinary cost of clearing land is about $15 an acre. Orange lands in full bearing are now selling at $1,000 an acre. In the sixth year after planting, an income is to be expected from the orchard, which will increase year after year in proportion to the skill and care displayed in cultivation.



GENERATING POISONOUS GAS TO KILL SCALE INSECTS.

The new Morningside exchange of the New York Telephone Company represents an investment of $300,000 and has a capacity for 72,000 wires. It is located on 124th Street near Seventh Avenue, and has just been opened for use. The switchboard alone cost $125,000. It is equipped with a newly patented device, by means of which any of the subscribers on a party line may be called up without ringing the bells of the others.

RECENTLY PATENTED INVENTIONS.

Agricultural Implements.

CULTIVATOR.—G. K. SPITZENBERG, Forsthaus Linzmühle, near Pfaffendorf, Brandenburg, Germany. Primarily this implement is for forestry cultivation, but may be used also in agriculture and horticulture. The soil to be treated is loosened and mixed to the required depth, by means of rotarily-moving knives or blades, without reversing the layers of soil. This is done in such manner that (in forest soil) the vegetable soil will be most plentiful on top and no sharply-defined line will exist between loosened and unloosened soil. Pressure is then brought to bear on the loosened soil, which is finally covered with a fine loose granulated layer.

BAND-CUTTER AND FEEDER.—J. H. FLORENCE and J. E. MISNER, Wichita, Kan. In the operation of this machine, the straw carrying the grain is fed to the endless carrier and is carried upward to the band-knives, which cut the bands. Thence it passes to one of the retarders near to the upper right-hand end of the carrier, this retarder having considerable speed, after which it passes over this to the other retarder, which has a comparatively slow speed, and thence to the wheat-wheel, the straw being operated upon by the rotary knife. The straw-gate prevents the straw from passing through, so that the knife acts directly upon the straw; otherwise the device works as any other similar feeder.

Dentistry.

MANUFACTURE OF DENTAL CROWNS.—E. V. WILLIAMS, Argyle, Wis. Practically embodied in the patent here presented are certain new and useful improvements in the manufacture of dental crowns, whereby a seamless crown is produced conforming in every detail as nearly as possible to the original tooth.

ARTIFICIAL TOOTH.—W. F. WHEELER, Spencer, Mass. Mr. Wheeler furnishes in his dental invention new and useful improvements in artificial teeth whereby their cost is greatly lessened, and at the same time a very strong and durable attaching stud is provided. The stud can be made of less expensive metal than that required for the socket, and as both are not made of the same expensive material it is evident that the tooth can be very cheaply manufactured.

Electrical Devices.

ELECTROHYDRAULIC VALVE.—C. ENBERG and J. ERICKSON, St. Joseph, Mich. This invention relates to an appliance operated by electricity for opening and closing a valve for a hydraulic conduit or analogous structure. By aid of the mechanism of this device, an operative may open and close any hydraulic valve, however cumbersome, by the mere pressure of a finger. If desired, the wires may be run any length, and the operative be able to actuate the valve from such distance.

Engine Improvements.

EXPLOSIVE-ENGINE.—J. WILLOUGHBY, Brooklyn, N. Y. In its preferred form this engine embodies a double crank-shaft to which are connected the rods of four pistons, working, respectively, in four cylinders, and giving four impulses to the shaft during every revolution. By air compressing means the products of combustion are swept out of the cylinders immediately before fueling, which operation is controlled by a cam working in time with the movement of the cam-shaft.

APPARATUS FOR TESTING PRESSURE-GAGES.—A. G. WOOD, New York, N. Y. The device enables an inspector to make a quick connection with the gage to be tested without disturbing the gage's position or connection to accurately test the gage, and in case of such gage being located on a locomotive, for instance, to allow of testing it along the route, whether the engine be dead or under steam.

AUTOMATIC CYLINDER-COCK.—E. L. JONES, Memphis, Tenn. When water of condensation collects and is allowed to remain in steam-cylinders it will form a resisting medium that is only slightly compressible and frequently causes cylinder-heads to be forced off by the reciprocating action of the piston within the cylinder. Mr. Jones's device will automatically drain off the water of condensation which may collect in a steam-cylinder. The contrivance may be operated by hand to drain off any water of condensation when the engine is not running.

Hardware.

NUT-LOCK.—W. NOBLE, West Union, W. Va. The inventor adapts this improvement for general application to screw-bolts without alteration of the bolts and also upon square or hexagonal nuts with but slight change. that will not materially add to cost of production. the nuts being held at any desired point on the bolt thread against displacement. but capable of removal by a suitable wrench.

SPIKE-PULLER.—T. G. BROWN, Gillespieville, Ohio. Certain details of this tool provide increased usefulness over those heretofore made and at the same time afford maximum strength to withstand rough usage. Adjusting means are provided by which the pivoted jaw may be set as desired to insure proper gripping action. The puller will effectively grip hard and smooth spikes and spikes of varying sizes.

Miscellaneous.

GALLEY.—P. J. COONEY, Philadelphia, Pa. The improvements in this invention are directly allied to the printing business, and more particularly to the production of a galley having an efficient lockup so arranged as to avoid distortion of certain delicate parts of the galley. The quoin, screw, and all parts of the device are non-detachable, so that the user always has a complete galley ready for use.

VITRIFIABLE PHOTOGRAPHIC DECORATION.—L. CRABTREE, Newark, N. J. Embodied in this invention are new and useful improvements in vitrifiable photographic decoration for producing photographs especially designed for decorative effects on china, glass, earthen, and stone wares, enameled metals, or other material yielding to vitrifiable decoration, the photograph appearing indestructibly on the finished article in a desired color and without a gelatin carrier.

COOLER.—F. GUTTENBERG, Brooklyn, N. Y. This is a portable device arranged to keep the liquid cold without danger of becoming contaminated by ice or other cooling medium, the construction allowing quick removal of an empty receptacle or the ready insertion of one filled with plain water, or liquid, to be cooled.

OBSTETRICAL SHEET.—SARAH FAULKNER, New York, N. Y. Incorporated in this sheet is a pad of two or more, preferably six, sections or members placed one upon the other and so attached that a solid section may be quickly and easily removed, exposing a lower and clean section. The several sections are so constructed that they will be comfortable to lie upon and of an absorbent nature with protective covering, which will prevent one section soiling another or the bedding.

RIDING-STIRRUP.—W. G. MURPHY, Yankton, S. D. A rider wearing an ordinary boot, shoe, or any footwear, can use this device with ease and freedom, as the movable shield is so shaped that it conforms to the instep, and a broad convex surface minimizes the friction on the foot. The stirrup resists the strain or pressure of a falling horse, and the shield tends to brace and strengthen the side portions of the stirrup which will not give way and break when fallen on. The shield has a free swinging play in an upward and rearward direction; but is so disposed that the upward movement is limited or arrested by the cooperation of the stirrups in order that the shield may be prevented from moving too far and to cause it to drop by gravity back to its normal operative position.

SUSPENDERS.—I. WECHSLER, Brooklyn, N. Y. This invention bears particularly on improvements in the back rings for suspenders, the purpose being to provide a back ring so advantageously arranged that the suspenders may be turned in it and held in position to pass over the wearer's shoulders or turned and held in position to serve as a belt.

DISPLAY-CABINET FOR RIBBONS.—N. LAFON, Earlington, Ky. Mr. Lafon has produced a ribbon-holding device that will exhibit the ribbons while in wrapped-up condition, and he has aimed to provide a cabinet with features that adapt it for convenient service to expose the end portions of ribbon bolts for inspection while in the cabinet and to suffer the removal of any bolt or ribbon, as may be desired.

CHAPLET AND SHRINE OF THE HOLY ROSARY.—T. SAULT, New Haven, Conn. The purpose of the inventor is to here provide a new and improved chaplet and shrine of the holy rosary designed for devotional purposes and arranged to enable a person to successively display pictures of a religious character one at a time and in proper order, according to the designated devotional exercise.

SLED ATTACHMENT.—E. C. WHITNEY, West Fitchburg, Mass. To prevent sleds from sluing or moving sidewise and at the same time to avoid complicating or increasing the cost thereof, the invention provides a gripper-plate of such novel form and arrangement that when the sled moves straight ahead the plate lies in inactive position, but as soon as the sled begins its sidewise movement the gripper-plate automatically becomes active and firmly grips the surface on which the sled is running, thus preventing sluing. The attachment is mainly intended for use in logging and other sleds carrying heavy loads, although it is applicable to sleds of all sorts.

LANTERN-FRAME FOR LAMP-CHIMNEYS.—E. F. WEIDIG, New Orleans, La. This invention is a lantern-frame, consisting of a base, wires rising from the base to a height to extend above a lamp-chimney, and a spring-bail connecting the wires and composed of crossed arms, a coil integral with the arms and forming a finger-hold, and a ring embracing the arms at the point of crossing. The frame, in connection with a crimp-top chimney and a candle, will form a very serviceable lantern.

RULER.—T. RAMSAY, Invercargill, Southland, New Zealand. Mr. Ramsay's improvements relate to rulers used in ruling and measuring paper and for analogous purposes. The invention belongs more particularly to that type of rulers in which there are two members, together forming a square. To persons accustomed to use rulers it will be readily apparent that this device can be applied to many uses.

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.

Business and Personal Wants.

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

MUNN & CO.

Inquiry No. 3805.—For a machine for cutting fruit into cubes about ⅜ of an inch in size.

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Inquiry No. 3807.—For a machine for embroidering monograms, etc., on handkerchiefs, table linen, etc.

Inquiry No. 3808.—For makers of elastic and all kinds of webbings.

Inquiry No. 3809.—For manufacturer of small motors and dynamos, also address of firm who makes Porter motors.

Inquiry No. 3810.—For makers of small hardwood cases.

Inquiry No. 3811.—For manufacturers of papier maché frames.

Inquiry No. 3812.—For a machine for weaving wire and wooden slats.

Inquiry No. 3813.—For parties who furnish material for fitting up an open hearth acid and crucible steel casting plant, using fuel oil.

Inquiry No. 3814.—For firms dealing in materials used in photogravure.

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Inquiry No. 3818.—For manufacturer of fancy silk cord and narrow tape.

Inquiry No. 3819.—For manufacturer of "Star" foot power screw-cutting lathe.

Inquiry No. 3820.—For manufacturer of solar motors.

Inquiry No. 3821.—For firms making compressed air machinery.

Inquiry No. 3822.—For makers of stenciling machines.

Inquiry No. 3823.—For makers of envelope-making machinery.

Inquiry No. 3824.—For manufacturer of machinery for making wooden faucets.

Inquiry No. 3825.—For makers of coal conveyors or elevators.

Inquiry No. 3826.—For makers of vending or slot machines.

Inquiry No. 3827.—For manufacturer of artistic furniture hardware, drawer handles, hinges, etc.

Inquiry No. 3828.—For manufacturer of pipe or bolt machine that cuts two threads at once.

Inquiry No. 3829.—For dealers in parts for direct current motors, using primary battery.

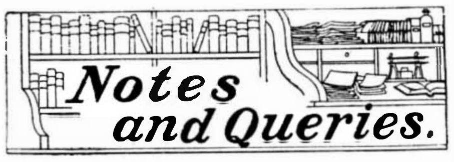
Inquiry No. 3830.—For manufacturer of balloons and silk for same, also dealers in rubber tubing.

Inquiry No. 3831.—For address of parties that furnish power plants.

Inquiry No. 3832.—For makers of small bicycle pumps, etc.

Inquiry No. 3833.—For address of builders of iron and steel piers.

Inquiry No. 3834.—For manufacturers of fancy metal novelties.



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.

(8843) A. C. A. writes: Is it possible to use watchcase telephone receivers as transmitters, and if so, how? A. It is possible to use a telephone receiver which contains a magnet and a coil as a transmitter for short distances. But such an arrangement is not used even for short distances, because the microphone is much more sensitive as a transmitter. This is used in some form in almost every transmitter in the country.

(8844) A. L. asks: Can any other metal be used in the elements of the Edison storage battery instead of nickel and iron, provided one is a superoxide? If not, why so? Could not the same metal be used in both elements provided again that one is a peroxide? Could not an oxide be used instead of a peroxide? A. No other metals can be used in the Edison storage battery than he has used, else it is no longer an Edison battery. There are metals which can be used for storage cells. It is, however, most probable that the most efficient have now been tested, and that none so good as these will be found. This will not however discourage inventors from still searching and trying to discover other forms. If a metal forms two oxides, it can be used for both plates. Treadwell's "Storage Battery" treats the subject quite fully.

(8845) W. S. O. asks: About how many ampere turns will it require to economically saturate a solid soft-wrought iron or steel core, 4¼ inches by 10 inches long, to be used as a field core for alternating generator of the induction type? A. About 750 ampere turns will be required to bring a bar of iron 4¼ inches in diameter and 10 inches long to practical saturation.

(8846) E. F. asks for the dimensions of a spark coil, size and amount of wire, also how long the core should be. Is there any insulation between primary and secondary winding? A. Jump spark coils are made in all sizes according to their use. Norrie's "Induction Coils," which we can send you for $1, gives full details for lengths of spark up to 12 inches. The details of construction are quite too long for a letter. A coil giving an inch and one-half spark is described in our SUPPLEMENT No. 160 and one giving a 6-inch spark in SUPPLEMENT No. 1,124. These papers are ten cents each. Our SUPPLEMENT, No. 1,402 has a valuable article upon the cores of coils and data for the winding of a full series of sizes. You may find all the instruction you require in this article. Strong insulation is always used between primary and secondary in large coils.

(8847) F. M. F. asks how the black lead is applied to wood in making electrotypes. I desire to copperplate wood, but am unable to get good results, owing to trouble in coating same with the black lead. A. Stir the black lead into melted wax, and apply this coating while warm; if it cools off too rapidly and is found to crack, a small amount of Venice turpentine can be mixed with the wax.

(8848) W. F. B. writes: Will a Fuller battery answer for an electro magnet described in "Experimental Science" instead of the bichromate of potash? I am unable to get a battery of that description with carbon inside and zinc outside; they are all made the reverse. Does the core of this magnet get saturated, and refuse to hold the armature? A. A Fuller bichromate battery will answer perfectly for the electro-magnet in "Experimental Science." A bichromate battery with the carbons on the outside of the zinc is just as good as any. It is the way they are usually made. Your idea of a magnet core is erroneous. The more strongly it is magnetized the more strongly it attracts, until a point of saturation is reached, when no further increase takes place and the attraction remains the same. If it does not attract at all, it is because there is no current flowing through the wire.

(8849) W. H. V. T. asks how to wire a clock to ring bells every hour. A. A clock can be wired to ring bells at equal intervals, as of an hour, by causing the minute and to close the circuit. This can be done outside the dial by a piece of watch spring bent so that the hand touches it, and makes a brief contact. It can be done on the inside of the case by a pin on the wheel which moves the minute hand. These arrangements require some ingenuity to make them work, and may alter the time-keeping qualities of the clock. The more complicated devices can be had from manufacturers. These are more reliable and satisfactory.

(8850) G. S. J. writes: What current will you get off the secondary of an induction coil, if the primary is charged with a battery, the current run through a vibrating circuit breaker, being alternating or interrupted? If an alternating current is put in the primary of a transformer, will you get an alternating or direct from the secondary? A. The secondary current from an induction coil is direct, but interrupted when the spark terminals are far enough apart, so that the spark at the making of the vibrator is suppressed. When the spark terminals are near together, a spark is given at both the make and the break and the current is alternating. If an alternating current is sent into the primary, no vibrator is used and the secondary current is alternating.

(8851) E. W. wants the best recipe for a paint to protect iron pipes from salt water. A. A series of relative tests made some years ago by an English chemist showed that red lead and raw linseed oil, or red lead and barytes with raw linseed oil, gave the best results.

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