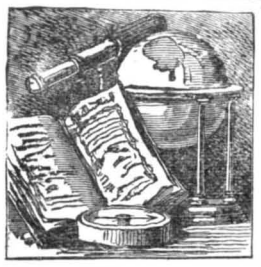

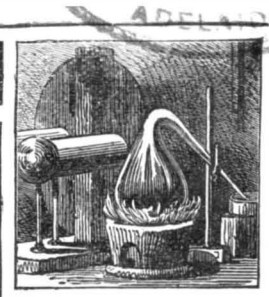

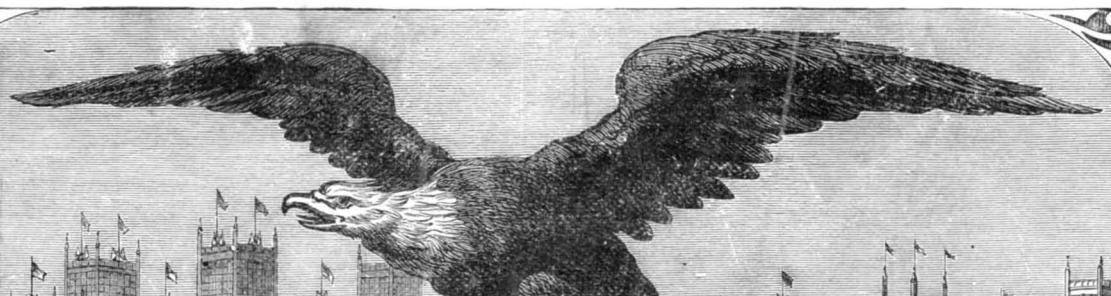

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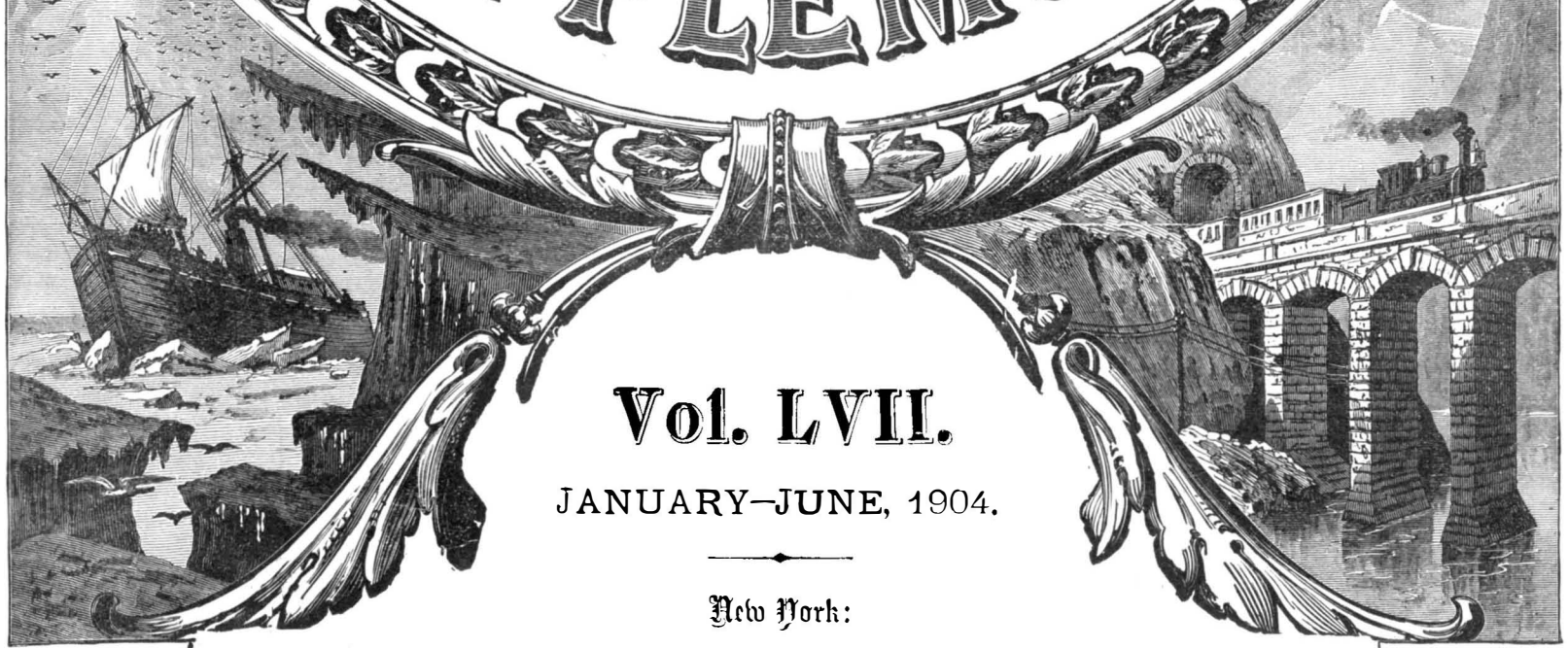

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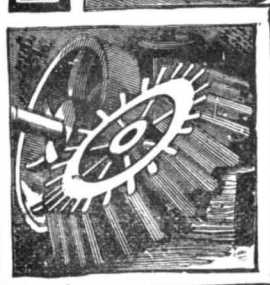

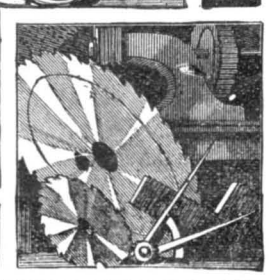

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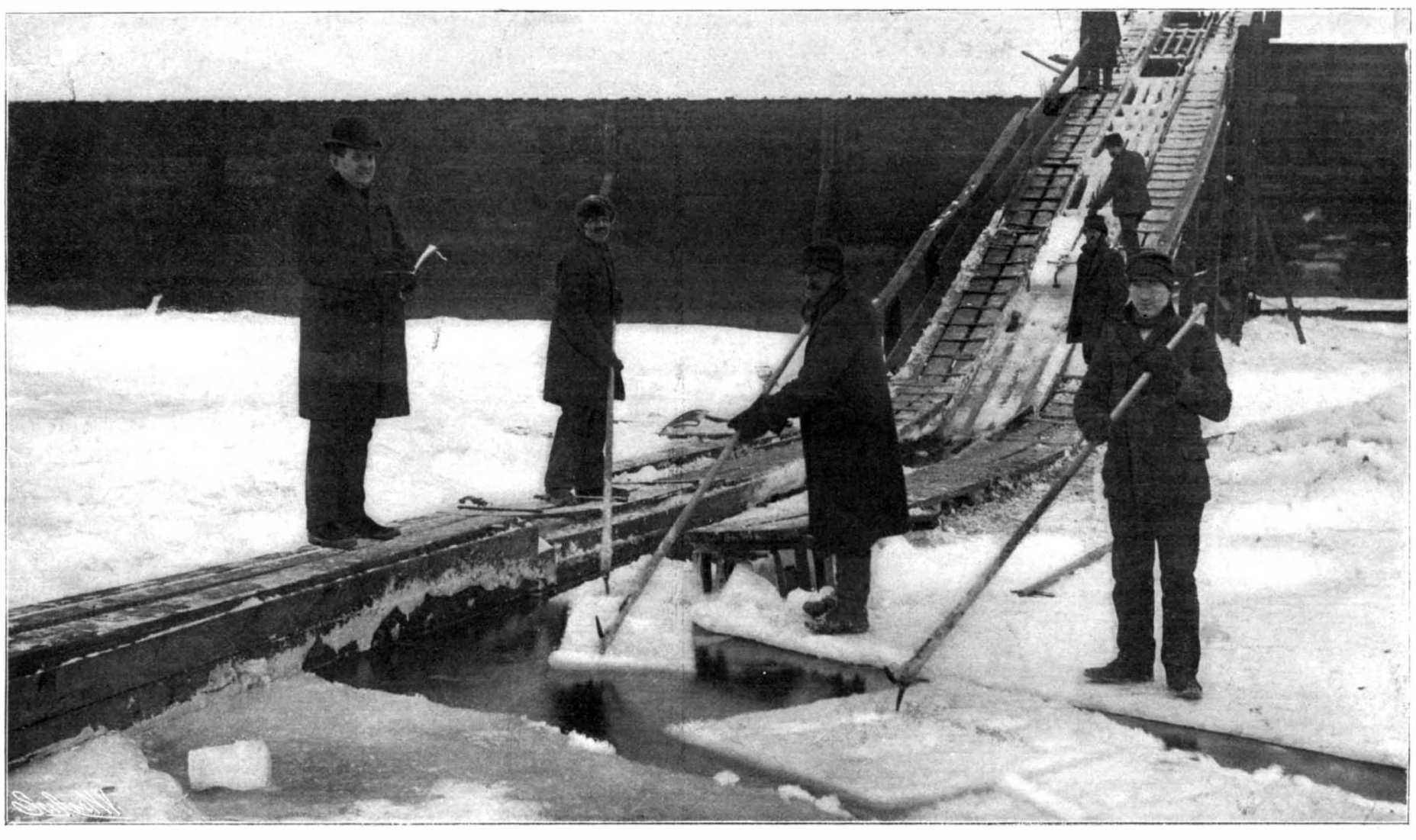
SAWING THE ICE.



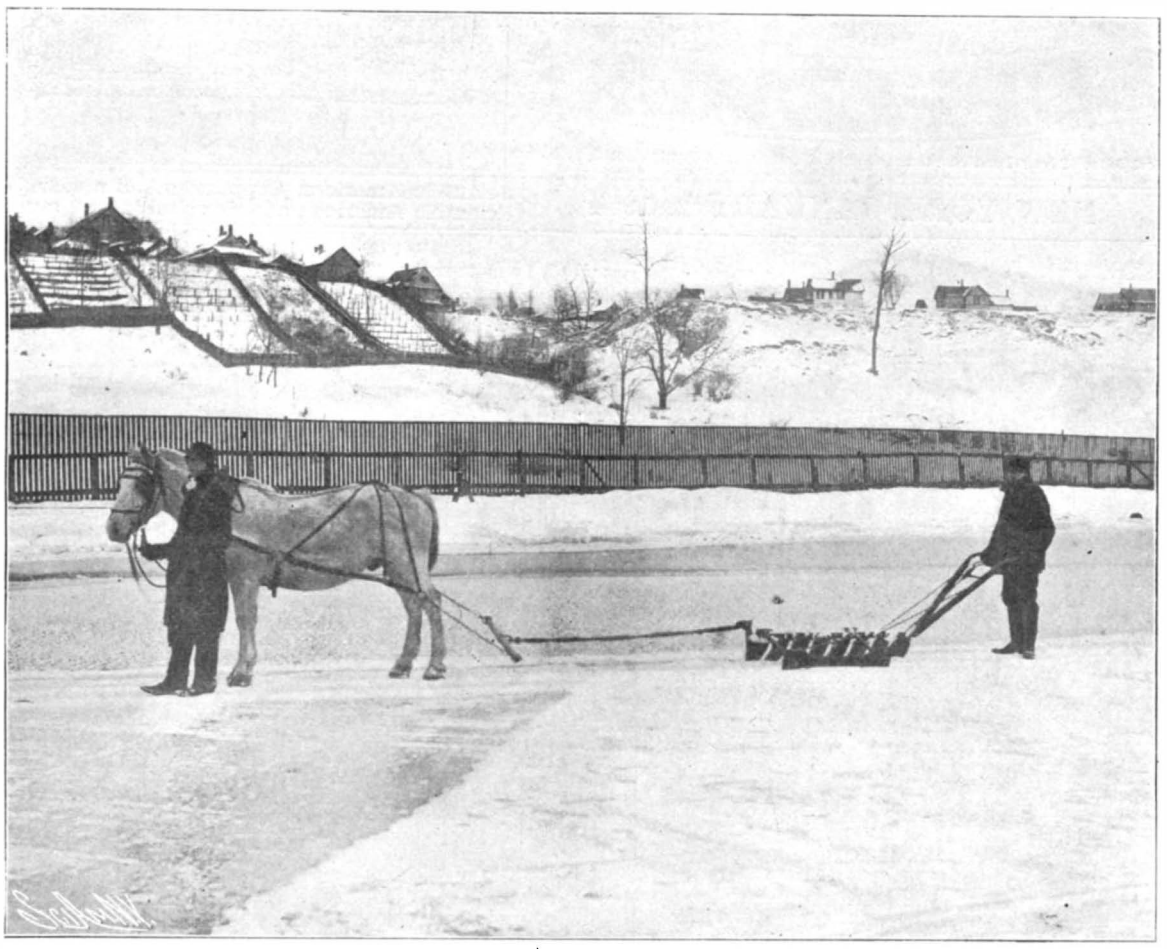
HOISTING ICE FROM CHANNEL TO ICE HOUSE.

ICE HARVESTING.

ICE HARVESTING.*

By W. FRANK MCCLURE.

THE Great Lakes furnish large quantities of ice annually to the great meat-packing centers of Chicago, Kansas City, and other western points. In fact, since the introduction of artificial ice for table use, the ice product of the lakes has been used almost exclusively



PLOWING AN ICE FIELD.

for packing and cooling purposes. Aside from the quantities which are shipped to a distance, much ice is stored in the ice houses at the lake fishing centers, usually in close proximity to the fish houses. At the fish houses the lake ice is used extensively in packing the shipments of fresh fish.

The ice industry on the lakes during the cutting season employs thousands of men. Of late years, the weather has been less favorable to heavy yields. Still, many new ice houses of large capacity are being built at the lake ports. Two or three severe cold waves will usually serve to fill the majority of the ice houses. These houses have an average capacity of 10,000 to 12,000 tons, though there are many much larger. A large portion of the ice cut upon the lower lakes last winter averaged 10 inches in thickness. The best ice-cutting weather is usually in February.

At Sault Ste. Marie large quantities of ice are stored for the purpose of supplying the vessels of the Great Lakes during the season of navigation. The necessary supply for the hundreds of vessels which ply between the upper and lower lakes, during nine months of each year, is by no means small. The storehouses and icehouses of the steel "trust," which supply its fleet of ore carriers, comprising more than one hundred vessels, are situated at the "Soo."

Sandusky, Ohio, has been for many years one of the chief centers of the ice industry. Each of several companies at this point has been known to load as high as one hundred cars a day for distant markets. Here the territory as worked covers several miles. The most promising sections of the fields of ice are selected and staked out. The snow is next removed from the surface over the area to be cut. Horses are brought into use in the operation of plowing furrows, which are cut to a depth of six inches. The furrows are run lengthwise of the field and are two feet apart.

A gang of ice sawyers next cross-cut the furrows at intervals of four feet. One of these gangs with saws in hand is pictured in the accompanying photograph. The blocks thus cut are therefore two by four feet in thickness. A channel, perhaps six feet in width, is opened from the field to the hoist or elevators. Different methods are employed at different places for forcing the cakes of ice through these channels to the runways of the storehouses. The method illustrated in the photograph provides for forces of men known as "pikers," who stand beside the channels and force the cakes of ice, as fast as loosened, in the direction of the ice house. There are also various methods employed in hoisting ice up the runways. One of the common ones is to hoist the cakes by means of a horse, ropes, and purchase blocks. A later method provides for the operation of an endless chain system upon the runway.

A few miles south from the boundaries of Lake Erie are numerous ponds which are fed by springs, and from which ice is cut for table use. Great care is taken of these ponds. In summer they are drained, and before water is permitted to fill them again, the weeds are cut and cleared from the bottom.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE EFFECT OF LEMON JUICE IN LEMONADE UPON TYPHOID-POLLUTED WATER.*

By WILLIAM G. BISSELL, M.D., Buffalo, N. Y., Bacteriologist to the Department of Health.

THE investigation which I report was prompted by a newspaper statement purporting to come from the health department connected with one of the leading municipalities of the United States, that the amount of lemon juice ordinarily contained in the mixture known as lemonade was sufficient to render inert any typhoid bacilli that might be contained in such mixture, and that waters contaminated with typhoid were safe to drink when made into such a beverage. The investigation was carried on, using three distinct methods for testing, and the results were confirmed by a duplication of each test.

METHOD I.

In an ordinary glass of sterilized distilled water there was placed the strained juice of one half of a large lemon. This mixture, as shown by tests, was as strong as any that would ordinarily constitute a pleasing beverage of this character. In this mixture there was introduced 1 cubic centimeter of a forty-eight hour old broth culture of typhoid bacilli.

After the lapse of periods of time of five, ten, fifteen, twenty, twenty-five, and thirty minutes, respectively, 1 cubic centimeter of the lemonade typhoid mixture was introduced in each of three tubes of plain agar, lactose litmus agar, gelatin, and plain broth.

All tubes, with the exception of those of gelatin, were placed at an incubating temperature of body heat. After twenty-four hours there was distinct cloudiness in most of the bouillon tubes, with the exception of one five-minute tube, two of the fifteen-minute tubes, and two of the thirty-minute tubes. These tubes failed to reveal growth.

One fifteen-minute lactose litmus agar tube and one gelatin tube failed to reveal growth. It appeared to the writer that the failure to get growth in the instances stated was not due to the organism being destroyed by the germicidal action of the lemon juice, but because the presence of the small amount of free acid in the culture media had inhibited growth. In order to ascertain if this view was correct, culture medium was prepared, and after sterilization, minute quantities ranging from 1-20 of a cubic centimeter to ½ a cubic centimeter of lemon juice were introduced to each 10 cubic centimeters of medium.

Such tubes were inoculated with typhoid bacilli. In about thirty-two per cent of the instances the typhoid organism failed to grow. Check cultures of the same medium without the addition of lemon juice revealed decided growth in each instance. It seems fair to assume that Method No. I, as determining the germicidal action of this strength of lemonade to the typhoid organism, is not reliable. In view of these circumstances the second method was tried.

METHOD II.

In this method, forty-eight hour broth cultures of typhoid bacilli were prepared, and into each culture there was introduced a sterilized glass rod. After a few minutes' immersion the rods were removed and placed in individual sterilized test tubes, so that any material adhering to the rod would become dry. A lemonade mixture similar to that used in Method No. 1 was prepared, using the same proportions of lemon juice and water, but omitting the typhoid culture.

The typhoid-infected rods were placed in the mixture and after the lapse of periods of five, ten, fifteen, twenty, twenty-five, thirty, forty, and fifty minutes, the rods were removed and placed into different tubes containing 10 cubic centimeters each of sterilized distilled water. The object of this procedure was to cause the removal of any lemon juice that might be present. After being thoroughly washed in the water the rods were introduced into ordinary culture broth. After twenty-four hours at the incubating temperature there was not a single failure to obtain growth. In order to substantiate this result the third method was tried.

METHOD III.

Sterilized silk threads were saturated with a forty-eight hour old culture of typhoid bacilli and the threads allowed to dry. All threads were placed in the lemon mixture, and after twelve hours' immersion were placed in sterilized distilled water. After being washed in the water the threads were placed in culture broth. In not one instance covering a test of twenty-three threads was there failure to obtain growth in the culture broth.

* Read before Laboratory Section, American Public Health Association, at Washington, D. C., October 26, 1903.

THE "PIKERS" MOVING THE BLOCKS OF ICE.

ICE HARVESTING.

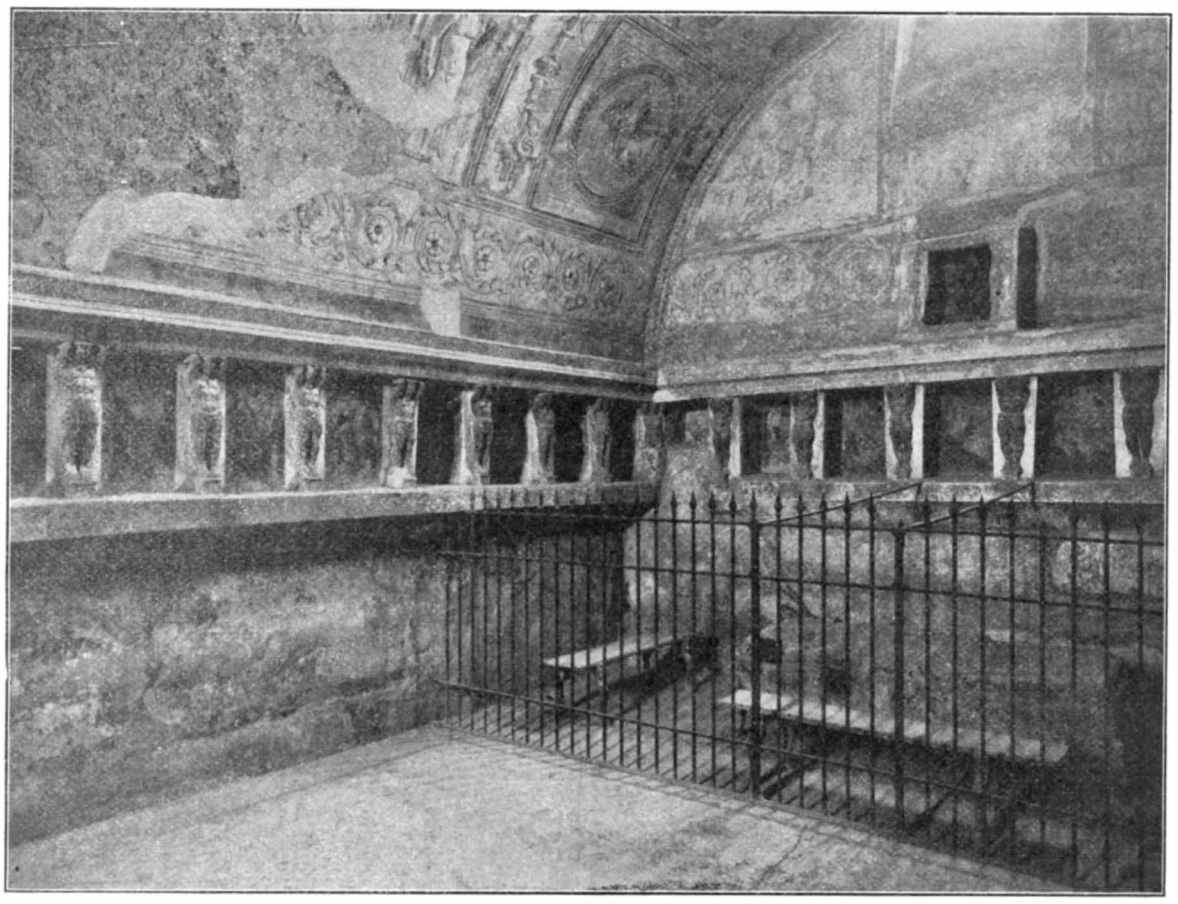
From the results obtained the following conclusions would seem justifiable:

First. That lemon juice in the proportion given has very little, if any, germicidal action upon typhoid bacilli.

Second. That this method of treating water to prevent a possible typhoid infection should be discouraged.

THE BATHS OF POMPEII.

AFTER excavations had been carried on for some time in Pompeii, the baths were discovered. This institution was superior to those which exist in our large cities to-day. They measured 162 feet by 93 feet. They were divided into three separate and distinct compartments, one of which was devoted to the furnaces and servants, while the others were devoted to baths for men and women, which adjoined by reason of the economy of fuel. The Pompeiian baths must not be compared with the Roman baths, where entertainments were provided. Furnaces heated the warm and vapor baths. Hot air was conducted by flues under the pavement. Cold, tepid, and warm baths were provided, The *tepidarium*, shown in our engraving, was so called from a warm but soft temperature, which prepared the bodies of the bathers for the more intense heat which they were to undergo in the vapor and hot baths, and *vice versa* softened the transition from the hot bath to the external air. This room is well decorated in stucco with terra-cotta Atlantes. The ceiling is worked in stucco in low relief. From the *tepidarium* the bather went into the *caladarium*, or vapor bath, and the other rooms essential to a complete "Roman" bath. We use radiators where the Romans used hollow floors and walls, but it is doubtful if the result in our baths is any better. Our Turkish and Russian baths of to day certainly had a valuable prototype in this admirably-preserved bath in the seaside resort called Pompeii.



THE TEPIDARIUM OF THE BATHS OF POMPEII.

TRICERATOPS PRORSUS—AN EXTINCT MONSTER.

PROF. CLARKE, of the U. S. Geological Survey, has long desired to show the public a restoration of a dinosaur and to display one at some of the many expositions in which during the last decade the government has been called upon to take part, and the Pan-American afforded a favorable opportunity.

There were in the U. S. National Museum some fifteen examples of a very curious reptile, called from the horns he bore triceratops, or three-horned-face, and while not a large dinosaur, so far as mere size goes, this was a good example for representation.

It was impractical to use the actual bones for exhibition, hence a model was prepared, which was perhaps more valuable from an educational point of view.

When it was decided to construct a model of a triceratops, it was decided to build it of papier mache, a mixture of paper, plaster, whiting, and glue, because this is easily modeled, is harder than plaster, and when worked over a properly constructed framework will stand considerable rough handling, and if broken will merely crack across and not fly into pieces. Each bone was roughly blocked out by a framework of wood, iron rod, and wire cloth, and over this was spread a coat of papier mache, which was carefully modeled into the shape of the bone, making straight all twists and turns caused by the pressure to which the original had been subjected. Some of the bones were simple enough, some were decidedly complicated, the head being one of the most difficult, the hip bones the worst of all. For in order to carry their share of the weight of a creature that in life must have weighed at least ten tons, these hip bones had need to be pretty large and very well braced. Moreover, Nature had been economical of material, and, like a good engineer, had chosen to support the weight by a series of cunningly devised struts and trusses, and the two main bones of the pelvis, which rest on the hind legs, were carried by no less than eight sections of the backbone, so that the strains were well distributed. And to reproduce all these bony processes was no easy matter.

Another difficulty was that in spite of the great size of the skull with its spreading frill and massive horns, its various parts were so thin that it was difficult to find a solid spot from which to start. The head was five and a half feet long and four and a half feet wide, and yet the only place that would admit a section of joist six inches square was just at the base of the horns; and from this, as a starting point, supporting irons were carried in every direction to form the framework of the skull.

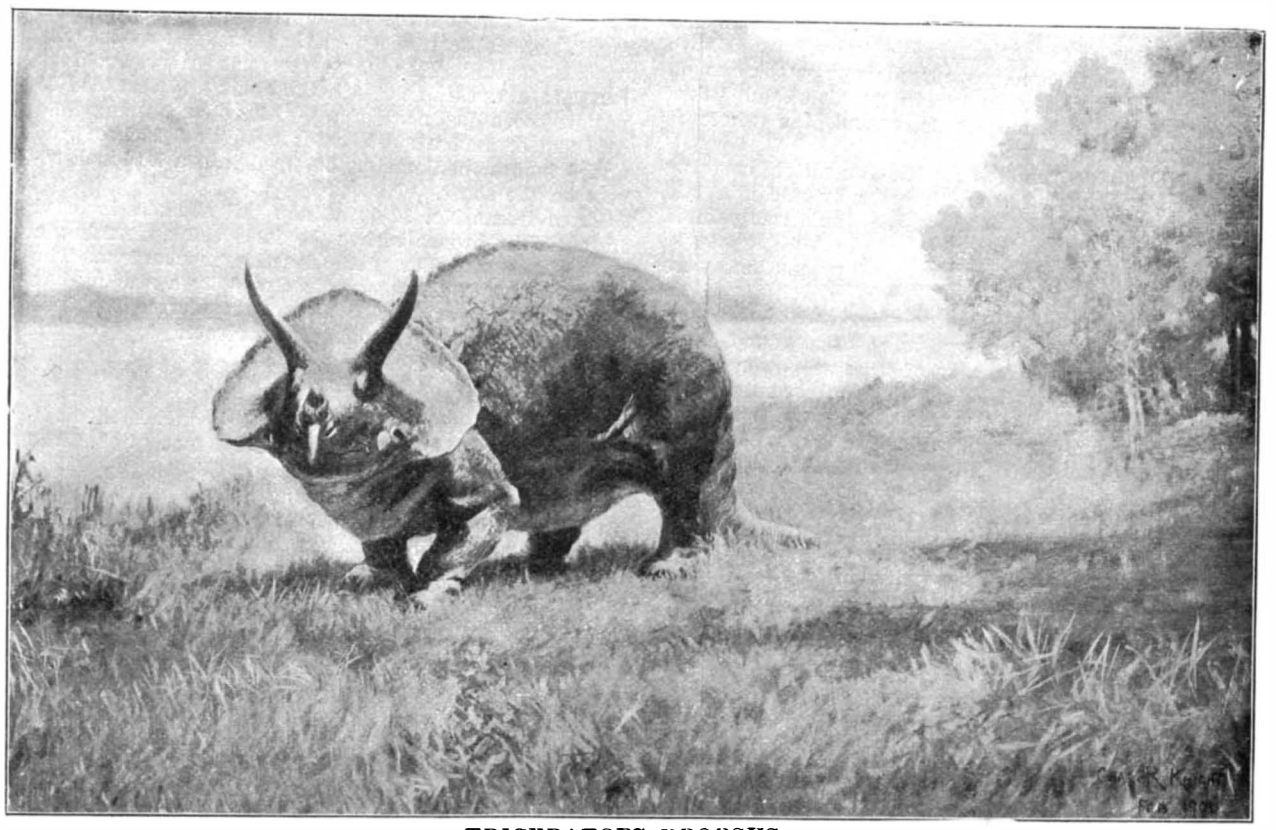
Borrowing from the methods of the modern builder, the big frill was supported by the twisted steel rods used in the construction of concrete floors, and with the same gain in strength and rigidity. The problem of sustaining the finished skull in its proper relation to the body seemed difficult, but unlike most problems this one solved itself; for it proved that the parts were so well balanced by nature about the junction of the head with the neck that a single heavy pin firmly built into the base of the skull sufficed to carry it. The huge skull, indeed, literally dominates the body; the bones of the neck are directly adapted to its support, while the fore legs are so much shorter than the hind that the creature could readily feed from the ground without the difficulty of lowering and raising half a ton of head for every bite.

Probably the mechanical difficulties in the making of such a restoration as this do not occur to the average observer. To him the modeling of the bones and the correct pose of the various parts seem the serious questions, when, as a matter of fact, these are comparatively simple. The real problem is to so construct the mimic skeleton that it will stand up in good shape with as few visible supports and braces as possible. The sections of the backbone with their various processes might seem much more difficult to reproduce than the ribs attached to them, but quite the reverse is true. To make a rib five feet long, no thicker than one's finger and thrice as wide, curving three different ways, is not an easy matter. It would take a skillful carver to fashion such a bone, and were it done in wood there would be too many weak places where the grain ran crosswise.

The reclaimed Potomac Flats with their flourishing groves of willows suggested the solution of the rib question, for each rib was outlined with a quarter-inch iron rod and this outline filled with willow withes. The flat body thus formed was wrapped with wire, then with Manila fiber, and lastly given a coat of papier mache in which the little details were modeled, the result being a strong and accurate facsimile of the original. There were twenty-six pairs of ribs in the framework of triceratops. Each vertebra was modeled over a wood and wire cloth frame, but while there were twenty-eight of these sections in the body, and as many more in the tail, no two were alike; each vertebra required a separate form, and each had to fit accurately with the one before and the one behind, and all had to accommodate themselves to the curves of the backbone as a whole.

The shape of the leg bones made them easy subjects, both as to internal structure and external modeling. They were made hollow, not only for lightness, but to admit the passage of a heavy pipe that sustained the weight of each leg, while additional strength was gained by running a cross-bar to one of the main supports of the body.

The preparation of this great model was the work of a year, and there were times when it seemed doubtful if it would be done by the time agreed upon; but when the first of May came and the gates of the Pan-American Exposition were formally opened to the public, the model of a triceratops stood complete upon its pedestal just within the north entrance of the Government building. It stood at the highest part ten and one-half feet high, measuring from the tip of the nose to the end of the tail twenty-five feet.



TRICERATOPS PRORSUS.

SEA WATER FOR STREET WATERING.

SOME years ago the municipal authorities of Hastings tried the experiment of employing sea water for watering the streets and flushing the sewers and their example was soon followed by the local authorities of a number of other towns on the coast. The wastefulness, not to say folly, of using for such purposes water that had at considerable labor and expense been filtered to the highest attainable degree of purity seemed obvious; and though, of course, it involved the installation of a separate system of pumping station, mains, and hydrants, the fact that the supply was inexhaustible and itself cost absolutely nothing was so evident that it was strange that this source had been neglected so long. The sanitary and economic results seemed more than to justify the innovation, for, to say nothing of its slightly antiseptic action, the hygroscopic property of the salt caused the effects of each watering to last for a much longer time, and the surface of the roadway was believed by some to be more compact and cohesive,

than when fresh water was employed. Besides these retrenchments the new system presented a direct source of revenue in the demand by many private householders for a salt-water service to their bath rooms so that they might enjoy the luxury of sea bathing at home. But a few years' experience has unfortunately brought about no small disillusionment; the owners of carriages complain of the destructive action of the salt mud on the varnish and paint and the tradesmen complain of the injury inflicted on goods of all kinds by the salt dust and its subsequent deliquescence. Lastly, the users themselves, the local authorities and their private customers, have discovered that the salt water exerts such a corrosive and generally destructive action on metal pipes and fittings that the number of persons contracting for a domestic supply has fallen from 200 to 2, and the leakage from the joints of the street mains has caused the deaths of the trees planted in the best streets and promenades, so that the engineer to the corporation that had been the pioneer in the movement finds himself compelled, in an exhaustive report of its experience, to admit that the system has proved a complete failure.—Lancet.

[Concluded from SUPPLEMENT No. 1460, page 23395.]

THE DEVELOPMENT OF THE SUBMARINE IN THE DIRECTION OF INCREASED SCOPE.*

A STUDY OF THE LAKE SUBMARINE TORPEDO BOAT "PROTECTOR."

By Lieut. JOHN HALLIGAN, JR.

ENGINES.

THERE are two four-cylinder, four-cycle, White & Middleton gas engines, each of 120 horse power, on box-girder foundations, between frames No. 23 and No. 27, and with shafts 5½ feet apart. The four cylinders are of 10-inch diameter, with a stroke of 12 inches, and, with the bases, are water-jacketed.

The ignition of the combustible, which is generally a source of trouble in engines of this type, is effected by:

I. A primary dry-cell battery.

II. A Holtzer-Cabot Co.'s magneto.

III. A current from the storage batteries.

With this combination, no trouble has been experienced due to lack of current.

Provision is made for using the engines in the third stage of submergence (with sighting hood out of water); the exhaust in this case being under water, and air for induction being taken through a water-excluding valve in the top of the sighting hood.

ELECTRIC MOTORS.

Generator Motors.—There is a six-pole, shunt-wound Diehl motor in each main-shaft line, the armature shaft of which is connected to the engine-crank and to the tail shaft by clutches. When only the engines are being used for propulsion, the armature revolves freely, with brushes lifted, and serves as a flywheel.

Each machine has a rated capacity of 37½ kilowatts at 125 volts, when driven at 300 revolutions per minute—a range of E. M. F. of from 80 to 160 volts, and a current capacity of 300 amperes at full load, with a momentary capacity of 450 amperes.

As in the case of the "Holland," the ordinary armature insulation has proved insufficient, and the armatures have been rewound in the following manner:

The conductor, with its cotton covering, is baked to dry, dipped in varnish and baked twice, wound with three 0.01-inch thicknesses of red rope paper, wound with insulating tape, dipped in varnish, and baked twice. After the armature is wound, the whole is again dipped and baked.

Originally, the conductor with its cotton covering was simply insulated from the core by micanite laid in the slots, and, after winding, the whole was painted with Armalac.

The field coils, as a measure of precaution, were given a similar insulation.

Anchor-Hoist Motors.—In the after end of the crew space, on each side, is a two-pole, series-wound Diehl motor, with a rated capacity of 2 horse power at 110 volts, when driven at 1,450 revolutions per minute.

The armature shaft is vertical, and carries a worm at its upper end, through which it is geared to the shaft of the winch. Control of the motors is had from rheostats in the conning tower.

BATTERY COMPARTMENT.

It has been well said that if one were to look for a location for a storage battery wherein obtained all the conditions to be avoided, it would be found in a submarine boat.

In installing batteries on shore, care is taken to provide a roomy, well-ventilated, accessible place, free from moisture and from jar and shock. The difficulty in fulfilling these conditions in the limited space of a submarine boat, subject to rolling and pitching, is self-evident, particularly when it is considered that on account of their excessive weight the batteries must be carried in the bottom of the hull, beneath the flooring.

The storage battery installation of any submarine, therefore, is of peculiar interest in that it represents a difficult bending of conditions to suit a motive power, unsatisfactory as regards weight and space required, and endurance, but which, since it is the only power known which will give the required speed and radius without consumption of air, is a necessary evil in the submerged condition.

* Reprinted from the Journal of the American Society of Naval Engineers.

The storage-battery compartment of the "Protector" is mainly under the screw space, the floor of which is worked in transverse rabbeted strips of oak, alternate strips being easily removable for examination of cells. Side rows of cells are carried 12 inches higher under the transoms, the construction of the base of the transoms being similar to that of the floor.

The bottom of the compartment is of creosoted pine, laid in concrete and covered with a special mixture of non-conducting cement. Wooden partitions are worked longitudinally to separate the rows of cells. Spaces between the cells are filled with asphaltum cement, for purposes of rigidity and insulation.

The compartment is suitably ventilated.

Storage Batteries.—There are sixty Gould cells, with spun plates of the Planté type, of the following general dimensions:

Weight of cell complete, pounds	1,198
Total weight of battery, with asphaltum	75,895
Over-all dimensions of cell, inches	35 5/16 by 18⅞ by 16 11/16
Number of plates in cell	17

	Positive.	Negative.
Projected area of plate, square inches	837	837
Developed area of plate, square inches	8,931	10,422
Ratio of surface development	10.6	12.4
Estimated life of plate (in shore installation), years	5	7½ to 10

	8 hours.	5 hours.	3 hours.	1 hour.
Capacity of battery at varying discharge rates, in ampere hours.	2,240	1,960	1,680	1,120
Electrical horse power	42.5	59	85.5	..

The battery can be discharged at a rate well beyond the capacity of the motors without injury to the plates.

The plates are electro-chemically formed, and are contained in cases of antimonious lead lined with lead. They are supported and insulated from the case by plate glass, and are separated from each other by hard rubber tubes. The top of each cell is provided with an antimonious cover, carrying a rubber gasket, in which is left a center opening 5 by 5¾ inches for terminal connections and to permit examination of the cell and readings of the acid density.

The installation is designed to permit an inclination of 45 degrees in any direction without spilling the electrolyte.

SHAFTS, CLUTCHES, AND BEARINGS.

The main shafts are solid, of 3-inch machine steel, worked parallel, with bearings and clutches as follows:

At the after end of each engine, connecting the crankshaft with the dynamo shaft, is a 24-inch Frisbee clutch of special design. The hub of this clutch, 6¼ inches in diameter, is received in the forward armature-shaft bearing, 4 inches long, at frame No. 28.

At frame No. 30 is the after armature-shaft bearing, 5½ inches long.

The armature shaft is connected to the tail shaft at frame No. 30½ by a Frisbee clutch similar to the other. On the forward hub of this clutch, on the port side, is the driving-gear wheel for the air compressor.

At frame No. 31¼ is a 6½-inch bearing for the tail shaft, with a cast-iron pedestal bolted to the floor.

All bearings are bronze bushed and babbitted.

At frame No. 32 is a roller thrust-collar bearing of the following description:

A cast-bronze thrust block, 12 inches long by 8 inches wide, is bolted and babbitted onto a built-up base, and carries two shaft supports spaced 5¾ inches apart. A cast-bronze cap in the form of a yoke bolts to this casting. The shaft supports carry bushings bored to a working fit with the shaft and threaded to permit the adjustment of a 6-inch roller bearing held by them against a split cast-iron collar 3 inches wide and 6 inches in diameter, clamped into a 1-16-inch recess on the shaft.

From frame No. 32½ aft, the tail shaft is inclosed in a Tobin bronze sleeve ¼ inch thick, forming a part of the propeller pitch-adjusting mechanism. The forward end of this sleeve is closed by a stuffing box packed with hemp. The sleeve aft pierces the hull through a cast-iron stuffing box riveted to the hull plating at frame No. 34.

PROPELLERS.

The propellers are four-bladed, 45½ inches in diameter, with iron blades cast with a 3-foot pitch. The developed area of each propeller is 6.8 square feet.

Provision is made for varying the pitch from 5 feet in the go-ahead motion to 5 feet astern, by hydraulic gear. This adjustment serves the following ends:

I. There is no gearing in connection of motors to driving shaft.

II. By decreasing the pitch, the storage batteries may be charged while cruising at reduced speed.

III. By increasing the pitch, the motors and engines may be used together for propulsion, giving 324 horse power for higher speed.

IV. The speed may be controlled and the propellers reversed without the use of the motors.

These propellers have proved unsatisfactory, having developed a slip of 35 per cent at full power.

This has been due assumedly to—

I. An insufficient diameter.

II. A relatively high projected area of blade, which, there being four blades, gives insufficient clearance, with corresponding hindrance to flow of water, between the blades.

III. Inaccuracies in pitch, due to warping of castings.

The longitudinal position of the propellers is such as to prevent a material betterment of the first condition.

New three-bladed propellers with blades of bronze, and of the following general dimensions, are being installed:

Diameter, inches	49
Cast pitch of blades, feet	4
Projected area, square feet	7¾
Developed area, square feet	8½

Air Compressor.—The compressor is located abaft the port engine, between frames No. 30 and No. 32½. It is designed to compress 60 cubic feet of free air per minute to 2,100 pounds when running at 200 revolutions per minute. The working speed is 150 revolutions per minute.

The principal feature of its design is its compactness, it being 47 inches long, 22 inches wide, and 34 inches high, except at high-pressure crosshead guides, which are 41 inches high.

It is driven from the port main shaft by gears, which reduce the speed of the drive in the ratio of 2 to 1, and which consist of a bronze wheel carried on the hub of the after Frisbee clutch, and a cast-iron wheel on the face of the compressor flywheel, connected by a geared clutch of rawhide. The drive is taken from motor or engine.

The compression is in three stages, the first two of which are effected by trunk pistons; the high-pressure piston is actuated by a connecting rod, whose crosshead is carried in guides bolted on top of the high-pressure cylinder.

The cylinders are inclosed in a cast-iron tank forming a water-tight chamber, with a continuation providing an airtight chamber below the low-pressure cylinders, and with flanged standards by which the compressor is secured to the floor.

Air for induction is led from the highest point within the spindle hull to the air-tight chamber in the casing. As a further precaution against water, three separators are provided.

A small circulating pump discharges the circulating water from the upper after end of the casing overboard, the admission being at the bottom forward end, by gravity.

Handholes in the casing are located opposite the check valve of the circulating pump, and all induction and eduction valves.

Ballast Tanks.—Ballast and storage-battery tanks are worked to the top of floors forward and aft, ranging from 6¼ inches below the axis of the spindle hull at frame No. 9 to 24 inches at frame No. 30. Manholes are provided for all tanks but one.

Indicators of the following description are to be installed in accessible and visible positions for all ballast tanks: A bronze box casting, 8 inches by 12 inches by 3 inches, with a glass face, contains a copper float at the end of a bell crank, the other end of which carries a rubber-faced valve seating on the air vent of the tank. When the tank is completely filled, water rises into the indicator tank and closes the air vent.

Manifold.—The manifold is in three castings of gray iron, situated above the floor plates between frames No. 20 and No. 22. The sea connection is through a 7-inch globe valve on the port side, fitted with a strainer. There is a discharge on each side consisting of a 4-inch check valve steadied by a 7-pound spring.

The port side of the manifold has deliveries to the forward tanks and forward superstructure, and *vice versa*. All tank connections are of 4-inch pipes, except that of the after tank, which, for reasons of space, is 3-inch.

Pumps.—There are two special Rumsey rotary pumps, each with a capacity of 335 gallons per minute at 200 revolutions, and a 4-inch suction and discharge. They are installed on the floor plates, forward and outboard of the engines on each side, and are connected to the main shafts by clutch gears which reduce the speed of drive in the ratio of 12½ to 11½. Thus at 300 revolutions (the designed speed of the engines) the capacity of each pump should be 462 gallons per minute.

The pumps can be driven either by motors or engines, and are noteworthy for their compactness, their extreme dimensions, exclusive of connections, being 29⅛ inches by 19½ inches by 14 inches.

Auxiliary Pumps.—Forward of the engines on each side, and worked by an eccentric of the crank shaft, is a single-acting vacuum pump, with a 6¼-inch plunger, packed with cup leathers, and a 1¼-inch stroke. This pump discharges overboard, and has a connection to the floor level of the engine room.

On the starboard side at frame No. 32½ is a small auxiliary air pump, worked from an eccentric on the main shaft, and designed to keep up the pressure in the low-pressure system.

In tanks No. 1, forward and aft, are brass pumps of 3-inch diameter and 4-inch stroke, operated by levers above the floor plates. They serve for adjustment of ballast and trim.

Forward in the crew space is a hydraulic-pressure hand pump with 1-inch suction, ⅜-inch discharge, 1¼-inch plunger, and 4-inch stroke, with connections to the hydraulic cylinders of both wheels. The suction connects with an oil tank installed for that purpose.

A handy billy, with a 1¼-inch suction and 1-inch discharge, is used for sweating out ballast tanks. A sea delivery for this pump is provided so that it can be used in an extremity for emptying ballast tanks while submerged.

ACCOMMODATIONS.

The crew space, extending between frames No. 8 and No. 18, is finished in mahogany, and contains eight berths with pantasote cushions. The lower berths are in the nature of transoms, for which the upper

ones, when lowered, form backs. Above and behind the berths are lockers. A folding table is provided, the lower berths serving as seats. There are two electric heaters in this compartment.

Between frames No. 18 and No. 20 is the galley, with electric stoves and washroom. A water closet is located in the after engine room. An incandescent lighting system extends throughout the boat, there being 26 sockets.

SPEEDS.

There is no authentic data from which the speed of the "Protector," with the old propellers, can be obtained. The following best speeds have been estimated from unofficial timings entered in her log, and are without tidal corrections:

Light condition, engines and motors, 9.47 knots.
Light condition, engines only, 8.57 knots.
Submerged speeds have never been taken.

With the new propellers the designer expects speeds as follows:

Light condition, engines and motors, 10 knots.
Light condition, engines only, 9 knots.
Partly submerged, engines and motors, 8 knots.
Completely submerged, motors, 6-7 knots.

CRUISING RADIUS.

No records of fuel consumption of engines have been kept. The engines are guaranteed to deliver one horse power for one hour on a pint of gasoline. From rough calculations made during the longer runs of the "Protector" the gasoline tank capacity should give a cruising radius of 350 knots in the light condition at full speed.

By filling two of the ballast tanks with gasoline, this may be increased to 1,000 knots. This may be still considerably increased by carrying gasoline in barrels in the diving compartment or lashed on deck.

The submerged cruising radius with motors is likewise unknown. At full speed it is probably about 20 knots, and at an economical speed, about 30 knots.

SUBMERGENCE.

The most remarkable feature in the performance of the "Protector" is the facility with which her depth of submergence is controlled, this being of particular interest, aside from its importance, in that it is one of the few qualities of the boat that were not developed in her predecessors.

There are five stages of submergence, viz.:

I. The normal cruising condition, with superstructure and ballast tanks empty. In this condition the superstructure deck is about 16 inches out of water.

II. The war-time cruising condition, with superstructure filled and deck awash.

III. Superstructure filled and sufficient water in ballast tanks to submerge to the base of the sighting hood. This is the trim for submergence. A reserve buoyancy of about 280 pounds, corresponding to the volume of the sighting hood and omniscope, is maintained for all ordinary submergences. In this condition direct vision can be had through the sighting-hood lenses. While under way in this condition, by depressing the hydroplanes, two other conditions are assumed, namely:

IV. Submergence with nothing showing except the top of the omniscope.

V. Complete submergence.

To pass from the first of these conditions to the second requires about fifteen minutes; from the second to the third, about three minutes. Transition from one to another of the submerged conditions is almost at will, being well within the time required for an intelligent observation through the omniscope. This is, of course, of primary importance, inasmuch as when within sight of an enemy it is intended to run completely submerged, except for occasional verifications of bearing and range through the omniscope.

PROVISION FOR THE DISABLEMENT OF ELECTRICAL EQUIPMENT.

Propulsion for the first three stages is by engines and motors, singly or combined; in the last two stages, by motors alone.

The fact that in the third stage, by reason of an automatic induction valve in the top of the sighting hood, admitting air for the gasoline engines and excluding spray and water, the engines may be used, gives the boat a large cruising radius in this condition, at comparatively high speed, and renders it likely that, under many conditions of sea, light, and weather, the boat may get within torpedo range without being seen, in the event of the total disablement of her electrical equipment. In this case, of course, the omniscope would be housed, and the sighting hood, of a neutral color, could be discerned only with great difficulty. This feature assumes considerable importance when it is considered that the elements most liable to disability in the submarine of to-day are the storage battery and electrical equipment.

THE ADVANTAGES OF A DECREASE IN ELECTRICAL INSTALLATION.

It is intended in the near future to extend this advantage by taking the air for induction through the top of the omniscope, so that the engines may be used almost to the exclusion of the motors—certainly until within a mile of the enemy.

Could the electrical equipment of the submarine be removed in its entirety, the ability of the type to keep the sea without necessity of repairs would be increased three or fourfold, for it is only in this feature that the submarine is inherently short-lived.

With the diminution of the necessity of propulsion by motors, as outlined above, a great step in the direction of endurance is taken. It is believed under this condition, that instead of storage batteries sufficient to give a cruising radius submerged of twenty or thirty miles, a radius of ten miles would suffice. Such a limited installation would serve for all the probable requirements of an engagement, and for the less important electrical requirements of the vessel, namely, propulsion on the bottom, as when engaged in cutting cables, and illumination.

An idea of the increase in speed and cruising radius to be effected by an increase in gasoline-engine installation at the expense of storage batteries, considering the question of weights only, may be obtained from the following rough calculation:

In the "Protector," a weight of engines, fuel tanks, and fuel, of 28,131 pounds, gives 8,400 horse-power hours.

A weight in storage batteries and motors of 89,895 pounds gives a maximum of only 340 horse-power hours.

That is, in the gasoline installation, a weight of 3.55 pounds suffices to develop one horse-power hour, whereas the electrical horse-power hour requires a weight of 264.4 pounds.

TRIM WHILE SUBMERGED.

When submerging with the hydroplanes, the horizontal rudder is set to keep the vessel on approximately an even keel, compensating any eccentricity of longitudinal trim due to distribution of weights. While running submerged there are no restrictions on the movement of the crew. Frequent tests have been made with varying numbers walking the length of the boat. Two men weighing 320 pounds, moving from engine room to air lock, while submerged, produce an inclination of 1½ degrees.

NO GREAT SKILL REQUIRED TO CONTROL DEPTH OF SUBMERGENCE.

The efficiency and safety of the "Protector" under submerged conditions may be evidenced by the fact that no great degree of skill is required in maintaining a uniform depth, since the writer, on his first submergence, was allowed to operate the hydroplanes for five minutes, and succeeded in maintaining a depth between 25 and 27 feet. The control of depth, while more delicate at the higher submerged speeds, may be maintained at almost any speed.

SAFETY.

In a circular issued by the Navy Department in April, 1893, prescribing requirements to be fulfilled by competitive designs for a submarine previously authorized by Congress, and which circular stands to-day as an authoritative and official expression as to the requirements essential in a submarine, the first quality demanded was that of safety.

The value of the submarine as a weapon of war will be vastly augmented if there can be implanted in the crews of such craft a spirit of confidence. The work of the crew serving in a submarine will ever be regarded as somewhat hazardous in character, and therefore all possible means should be taken to lighten the nervous strain which must accompany such duty. Service would be performed much more efficiently by those who are imbued with the belief that skill in the handling of the boat could be easily acquired, than by the crew who, in addition to the dangers of combat, see dangers inherent to the construction of their vessel, operating perhaps under conditions of sea to which they are unaccustomed.

MEANS OF COMING TO THE SURFACE.

The general safety of the vessel and crew is contributed to largely, as previously mentioned, by seaworthiness and stability. To provide certainty of return to the surface from the submerged condition there are the following series of expedients:

I. The reserve of buoyancy maintained while submerged.

II. Emptying of ballast tanks by air pressure.

III. Emptying of ballast tanks by power pumps.

IV. Emptying of ballast tanks by hand pumps.

V. Release of anchor weights, with combined weight of 1,000 pounds.

VI. Release of 10,000-pound drop keel.

VII. Escape of the crew through diving compartment.

VISION, ORIENTATION, AND RANGE FINDING FROM THE SUBMERGED CONDITION.

The development of these features, which involve in so marked a degree the efficiency of the submarine while submerged, and particularly when in the critical position within torpedo range of an enemy, has in the past been so unsatisfactory as to affect seriously the ability to deliver a successful attack.

The problem of providing an instrument of this nature which will—

I. Project sufficiently above the hull to overlook the crests of seas without exposing any of the vessel;

II. Cover a horizontal field sufficient for the intelligent conning of the vessel;

III. Cover a vertical field sufficient to allow the observer to see the horizon during the changes of longitudinal trim to which the vessel is liable

—has been very difficult of solution in the case of the service submarines of the diving type.

THE ALTISCOPE.

In fulfillment of the first condition, the Naval Trial Board of the "Adder" and "Moccasin" recommended two lengths of observing tube, one to project 8 feet and the other 18 feet above the deck of the boat. Recent trials of these boats off Newport have demonstrated that, in a moderate seaway, the boats are controlled with great difficulty at depths less than 9 feet. Thus a long observing tube seems necessary to this type of submarine.

The internal diameter of the tube installed on these boats is about 3 inches. The dimensions of their conning towers prevent a material increase in this diameter. The result is that even with the shorter (8-foot) tube, the maximum field of vision without a reduction in size of image is about 1 degree, 48 minutes. This means that without an increase of field by reduction in size of image (as in looking through the wrong end of a telescope), one could not see the whole of the broadside of a 500-foot battleship at a distance of 2½ miles.

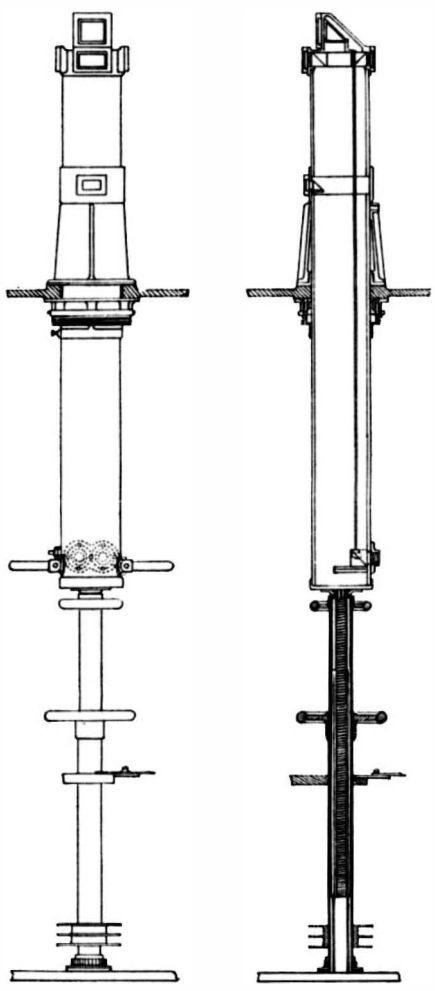
A reduction in size of image has been adopted in these instruments to secure a reasonable extension of field. But, inasmuch as the human eye, accustomed as it is to seeing things in what we consider their true size, loses all sense of distance when a reduction or magnification of size is effected, it seems logical to expect that for a successful estimation of range, at least, the commanding officer of a submarine must, in the absence of other means of range finding, be permitted to observe his target in its true size.

The most natural method of increasing the horizontal field on an observing tube is, of course, by rotation of the tube in azimuth. This again requires a conning tower of sufficient size to permit the observer to follow the eye-piece in its rotation.

THE OMNISCOPE.

In the "Protector," these difficulties have been anticipated by her stability and uniformity of longitudinal trim (she rises for an observation on practically an even keel), which—

I. Permit a comparatively short length of tube,



OUTSIDE VIEW AND CROSS-SECTION OF THE OMNISCOPE.

inasmuch as the porpoising, peculiar to the diving type, is absent.

II. Provide against the loss of horizon due to great changes of longitudinal trim.

And the size of her conning tower, which—

I. Allows the use of a tube of large diameter.

II. Permits of rotation of observing tube to cover a large horizontal field, and to obtain orientation.

The omniscope consists of a 6-inch rolled-brass tube, led up from a convenient level in the conning tower to a height, when housed, of eight inches above the top of the sighting hood. It carries five upper prisms, with lenses. Four of these, used as finders, look ahead, astern, and on each beam, each covering a field of 21¼ degrees, through a reduction in size of image. The fifth lens looks ahead and covers a field of 2 degrees, 40 minutes, and presents the image in its true size, without distortion.

The omniscope is capable of rotation in azimuth to cover the entire horizon, and it can be raised two feet. It works through a stuffing box packed with leather, and is given a 12-inch bearing to take the thrust while submerged.

Eye pieces and a lever for rocking the direct-vision prism to follow the horizon during slight changes of trim are provided at the base of the tube within the conning tower.

On the front of the tube, level with the top of the sighting hood, are a lens and prism to indicate the submergence of the sighting hood, it being customary when rising for an observation to show only the omniscope.

An automatic installation keeps the helmsman in-

formed of the bearing of the target, as seen through the omniscope.

On the lens of the direct-vision prism are two horizontal hair lines in the nature of a range finder. They are spaced to represent the height of a man at 300 yards, it being thought that in making an attack a man will generally be visible on the deck of the enemy.

THE TRYING OUT OF THE "PROTECTOR."

The "Protector" was launched at Bridgeport, Conn., on November 1, 1902. Since December of that year she has been in active commission, under command of her designer, with a crew of seven skilled men and a steward. This time has been given up to the solution of the many unforeseen problems of detail incident to the presentation of a new type of submarine construction, and to verifications and unofficial demonstrations of the capabilities of the boat.

Since July 9, 1903, the writer has been on board during all runs and submergences. Of these, most have been short runs out into Long Island Sound for submergence and torpedo trials. Submerged runs have been made at depths up to 48 feet, in depths of water to 16 fathoms, and in seas varying from smooth to moderately rough. In a rough sea there is some difficulty in trimming the boat for submerging, due to fluctuation of water level in buoyancy gage, but once submerged there is no difficulty in handling her under the conditions thus far experienced.

The following surface runs have been made under her own power:

From Bridgeport to New London.....65 knots.
New London to Newport.....48 knots.
Newport to Bridgeport.....98 knots.
Bridgeport to Port Jefferson and return, 28 knots.
Oyster Bay and return...50 knots.
Elizabethport N. J., and return .....120 knots.

The only tender used by the "Protector" has been a small gasoline launch towed astern, and used as a running boat.

ENDURANCE OF THE GASOLINE ENGINE.

All of the runs were made without a stop or delay of any kind due to trouble with the motive machinery, except that during one trip one of the eight cylinders of the gasoline engines failed to function on account of water in the induction pipe.

The marked simplicity of gasoline engines for such propulsive work, since such installation obviates the use of steam boilers and condensers, leads to the possible conclusion that the day may not be far distant when we may possess submarine cruisers, with an endurance of machinery afloat that is not possessed by the present high-speed surface torpedo vessels.

HABITABILITY.

While cruising the crew have always eaten and slept on board, the meals being cooked without difficulty on electric stoves. In all respects, save that of deck room, and under all conditions of weather, this boat provides greater comfort for the crew than the surface torpedo boats on which the writer has served.

DEDUCTIONS FROM THE PERFORMANCES OF THE "PROTECTOR."

Those most familiar with the construction and operation of the "Protector" regard her as an advanced design in the development of the successful submarine. The results secured show that this type of construction possesses qualities capable of elaboration, and that further increase in efficiency can be expected. The possibilities of the boat have been understated rather than overestimated.

It is safe to say the "Protector" has demonstrated—

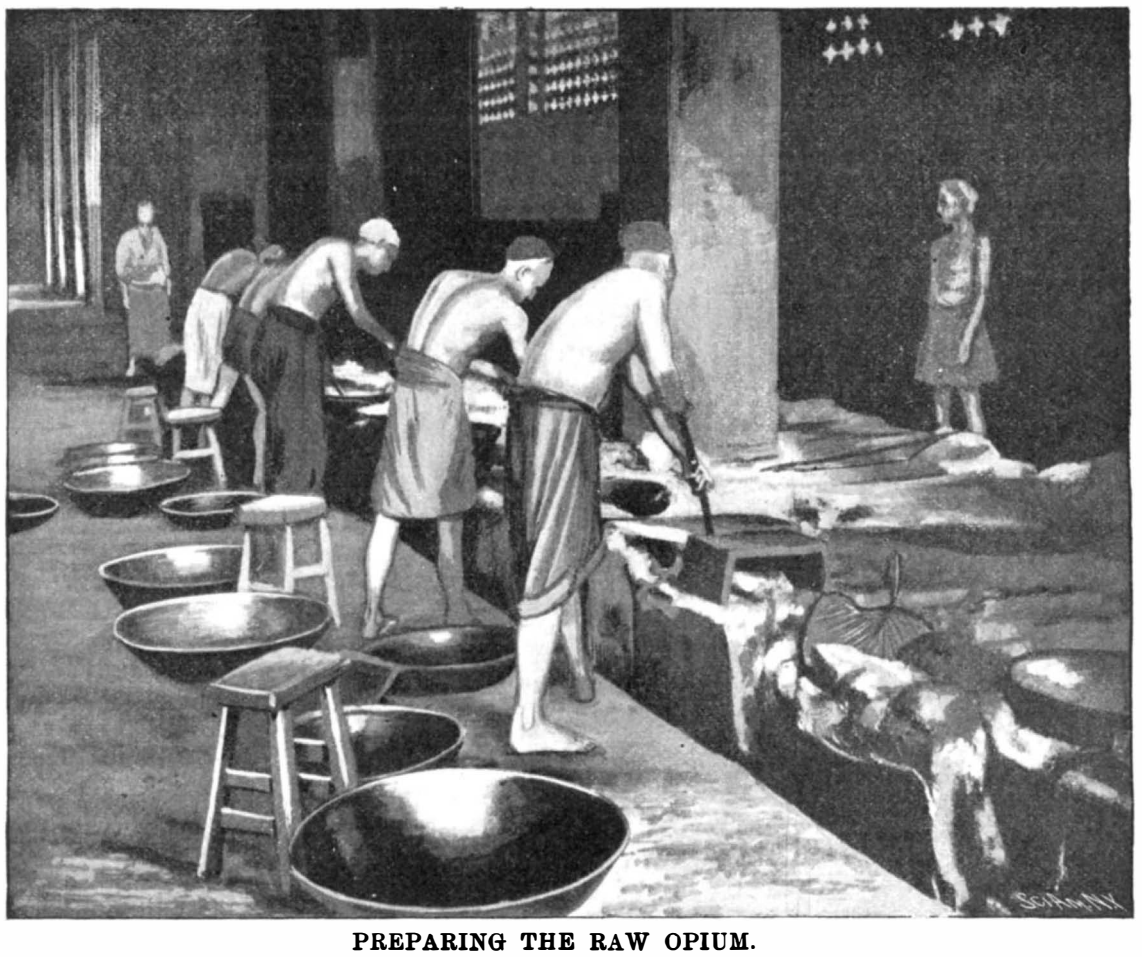
I. The possibility of submerging with facility and at will without dangerous destruction of longitudinal stability.

II. The ability in a submarine to combine seaworthiness and habitability to such a degree as to permit her to keep the sea for long periods unattended.

A study of the boat suggests—

I. That the logical development of the type will be a submersible cruiser of greater size and cruising radius, with a surface speed sufficient to enable her to run down her prey, and to cruise with a battle squadron.

II. That, if the development of the storage battery is not such as to greatly decrease the weight per unit of horse power and its liability to derangement, the electrical installations of the future in submarine vessels will be proportionally much less extensive than at present.



PREPARING THE RAW OPIUM.

IN THE LAND OF OPIUM.

FEW people have any idea of the vast areas given over wholly to the cultivation of opium. The consumption and the manufacture of this drug, far from being on the decline, are on the increase to an almost incredible extent. The greed for gold is far more predominant in the human make-up than is the philanthropic spirit which seeks to elevate mankind, though its purse may suffer in so doing. England reaps more benefit from the cultivation of opium than all other nations put together.

In the district of Bengal alone there are nearly 1,000,000 acres devoted exclusively to the cultivation of the poppy. Its cultivation is legalized and in every way encouraged by the British government, which has an absolute monopoly of this industry in India. The two principal districts are presided over by and under the direct control of English officials residing at Patna and Ghazipur. The Bahar agency embraces an opium field of about 500,000 acres, and that of Benares is a close second with 473,500 devoted to the cultivation of this much-talked-of drug.

MIXING THE OPIUM PASTE FOR SMOKING.

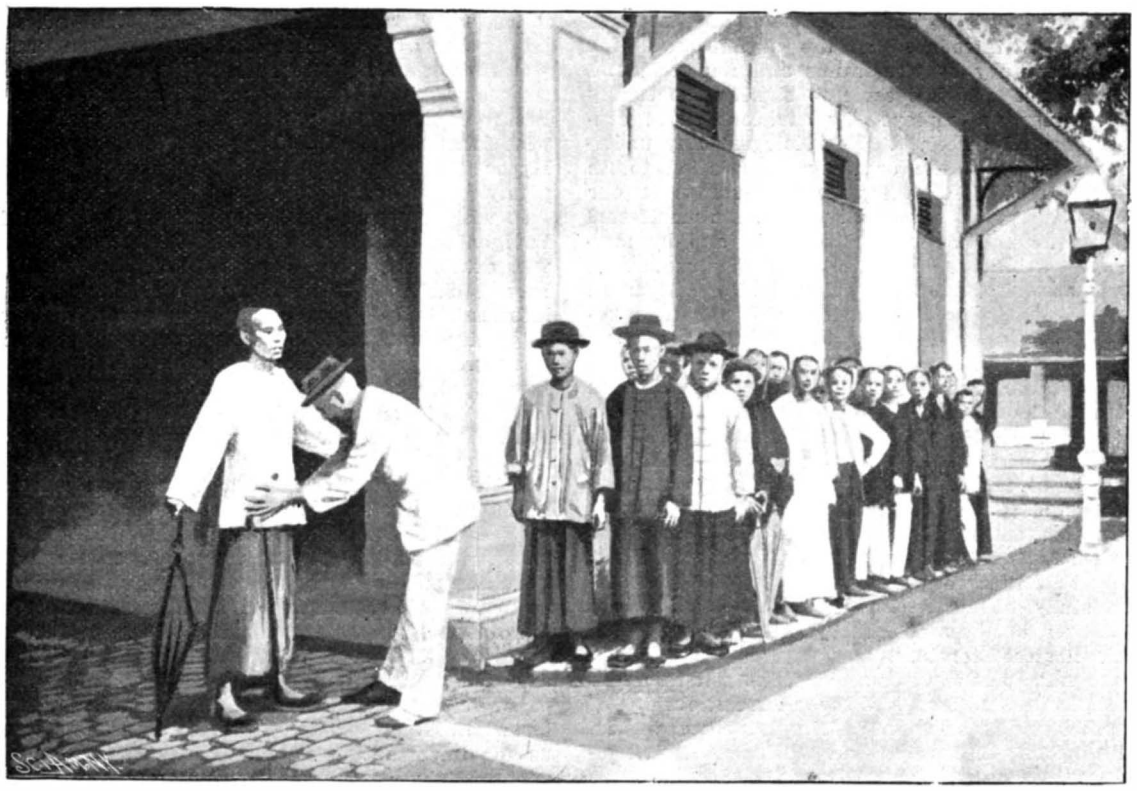
There is a fierce dispute going on just now as to the relative merits or demerits of opium. Many eminent men in the scientific world openly declare that opium is a blessing. The government experts in the country where it grows go so far as to say that opium is a blessing instead of being a curse to the natives. However, the vast majority of mankind will long be of the undivided opinion that opium is the most all-crushing curse that afflicts man. The enthusiasts, or, rather, extremists, of the International Anti-Opium Society picture the condition of India under the ban of opium in the most dreadful manner possible. According to one of these men, all of the 600,000,000 of human beings in Asia are exposed to the evils of the opium trade as legalized by the British government. In order to derive a revenue from it the Indian government issues licenses for the sale and consumption of this poisonous drug in vile places in all large cities, like Calcutta, Bombay, Madras, Lucknow, and Maulmain, and in all towns and villages of India and Burmah. These licenses are not issued for the purpose of limiting the sale of something that cannot be prohibited, but they are issued with the requirement that the holder of the license must sell a stipulated quantity or pay a forfeit! The more sold the more revenue the English crown will receive. As the opium is bought from the government agents, of course it is known how much the holder of the license sells. A member of Parliament who was most bitterly opposed to this traffic has been traveling through India gathering facts and seeing for himself what the condition of the natives is under an unrestricted use of opium.

It is worth a long journey to visit the poppy fields when the season begins. In February, as a rule, the plant is in full flower and has attained a height of three or four feet. Each stem has from two to five capsules of the size of a duck's egg. This is the time for the all-important operation of gathering the juice. Before the capsules are pierced the fallen petals of the flowers are carefully gathered and sorted, according to condition, in three grades. They are heated over a slow fire and formed into thin cakes, to be used for the covering of the drug when collected. This done, the piercing of the pods begins. This requires great skill, as the yield greatly depends on the exactness of this operation. The opium farmer and his assistants go about armed with a small lancetlike affair which is provided with three or four short, sharp prongs. With this a half dozen perpendicular cuts are made in each capsule or seed pod. The juice begins to flow at once, but quickly congeals. The day after all the thickened juice is carefully gathered, being scraped off with a small iron trowel expressly made for this purpose.

The mass thus gathered is put into an earthen vessel and kept carefully stirred for a month or more, great care being taken to have it well aired, but not exposed to the sun. This finished, the opium examiner comes along with his assistant, an expert tester. These two pass upon the grade produced, and when this is done the whole is put into a large box. Now it is worked very much in the same fashion as baker's dough, to give it the required consistency. After this operation is finished the opium is put into balls for exportation. This is a very interesting sight. The natives wade about in the large vats containing the paste-like drug and hand out the stuff to hundreds of ballmakers sitting around the room. Every man has a spherical brass cup, lined with the petals mentioned, before him. Into this is pressed the regulation quantity of opium. From this brass cup, when properly pressed, the opium ball is transferred to another man, who gives it a coating of clay. This gives the drug, when ready for shipment, the appearance of a fair-sized cannon ball. When well prepared in this manner, opium will keep its properties for fifteen years or more.

In this condition it is as yet raw opium and unfit for smoking. For some unexplained reason the final preparation of the drug to make it marketable for smoking is almost a monopoly in the hands of the Chinese. These people pay an enormous bonus for this privilege, but their profits are in proportion. The Chinese seem to be the most successful in giving this subtle drug the finishing touches. There are large establishments devoted to the preparation of the crude opium. Outside

of these factories there are pyramids of opium balls, which at first glance remind one far more of an artillery park than of an opium factory. The balls are broken, and after being removed are remoistened with a little water and allowed to stand about fourteen hours. They are then put into pans, two and a half balls with ten pints of water. After this has boiled for about ten hours it is reduced to a thin paste of



SEARCHING THE LABORERS.

uniform consistency. This is then transferred to a larger vessel and allowed to stand for fifteen hours. Then it is put through a great deal of filtering and various other processes, and finally put over a brisk fire. At a certain period it is quickly taken away from the fire and vigorously stirred until cold, the cooling being accelerated by coolies with large fans. When quite cold it is taken to a special room and kept there for some months before it is considered in prime condition for smoking. Prepared this way, the opium is of the consistency of a very thick syrup. It is put up in small boxes or jars of graduated weights to suit the customers. All such boxes have the name of the maker stamped on each package. In this condition the drug is exceedingly valuable, and all the employes are searched for hidden opium before they leave the factory.

PLANT FOOD FROM THE AIR.

FIVE years ago last September, says the N. Y. Sun, Sir William Crookes, in his famous address before the British Association, predicted a universal dearth of bread in the next generation. He endeavored to show that the wheat producing soil of the world is wholly unequal to the ever increasing strain put upon it; that the number of bread eaters had grown from 371,000,000 in 1871 to 516,500,000 in 1898; that the wheat growing areas could not possibly increase in the same ratio and their production per acre was constantly declining because the nutrients required by the plant are not fully restored to the soil.

There was only one way of salvation for a hungry world, and that was through the door of the chemical laboratory. All plants must have nitrogen in order to thrive, and nitrogen in a free state is one of the most abundant substances in nature. "Every square yard of the earth's surface has nitrogen gas pressing down on it to the extent of about seven tons—but this is in the free state and plants demand it fixed in the soil."

Nitrogen was to be the fairy godmother to save the world from bread famine, and Sir William predicted that the problem of the fixation of atmospheric nitrogen would be solved in a few years. It had already been discovered that by passing a strong inductive current between terminals the air takes fire, burns with a powerful flame, and produces nitrous and nitric acids. This discovery, he believed, was likely to lead to the development of a mighty industry destined to solve the great food problems in spite of the fact that barnyard fertilizers are wickedly wasted, that guano has disappeared, and that the nitrates of Chile will become exhausted in from twenty to thirty years.

The premises of Sir William and the food scarcity he deduced from them were stoutly, and it is believed successfully, contested; but his striking prophecy as to the practicability of the fixation of atmospheric nitrogen for the purposes of agriculture is coming true, and it is a matter of vast importance to the farming and other material interests of every nation.

As plants cannot use nitrogen as a gas chemists and physicists are now making every effort to devise mechanical means for securing nitrogen from the air in a fixed form. Very satisfactory results have been obtained in the past two years by the use of electricity, and the latest Yearbook of the Department of Agriculture says there is good reason to believe that it will soon be possible to place upon the market a manufactured nitrate of soda or nitrate of potash that will be superior in quality to the deposits found in Chile and will compete with them in price.

But still greater progress toward the same end is being made in another direction. It has been known for centuries that many soils, lying fallow for a considerable time, gain in nitrates without the aid of any manure or mineral fertilizer. It was not known till recent years that this increase in nitrogen content is due to a few forms of soil bacteria which have the power of fixing free nitrogen from the air and making it available for plant food. In his annual report for 1901 the Secretary of Agriculture called attention to the discovery of a new method of cultivating these soil bacteria. In his report for last year he announced that the new method had been perfected during 1902 and that the nitrogen gathering power of the bacteria grown by this method had been found to be five times as great as that of the ordinary forms found in nature. It had been supposed that these forms of bacteria were naturally developed only on the roots of leguminous crops such as beans, clover, peas, lentils, peanuts and others; but it has been proved that they have a much wider range of activity.

Not only methods of propagation but also of the safe distribution of these nitrogen gathering bacteria have now been perfected. Within the past few months the Department of Agriculture has been engaged in the wholesale propagation of these bacteria and in sending them to farmers for the inoculation of seed crops. The organisms are thoroughly dried and sent by mail in small packages of absorbent cotton, each package containing 15,000,000 bacteria, enough for the thorough fertilization of an acre. Immersion in water revives them and they are then fed on nutrient salts and multiply at an astonishing rate. The reports from co-operating farmers show the most favorable returns from the use of these organisms.

Mr. C. B. Lane of the New Jersey Experiment Station has given in the American Agriculturist of November 28 the results of some experiments with these bacteria. He says:

"After the bacteria, which grow upon any particular plant, have become well established in the soil this soil can be used to inoculate any other field by distributing in the same manner as fertilizer. The writer has some experiments with alfalfa in progress along this line. The soil in the plots was inoculated by applying soil from an old alfalfa field which was known to contain an abundance of bacteria. The first cutting, which has just been made, showed a gain of 18 per cent of inoculated plots over plots not inoculated, the plots otherwise being treated the same. Other plots inoculated with a solution made by mixing soil from the old alfalfa field with water showed a gain of 45 per cent over plots not inoculated. It is believed from the results thus far obtained that the method of inoculating with soil from old fields where the bacteria have become well established will prove very practical."

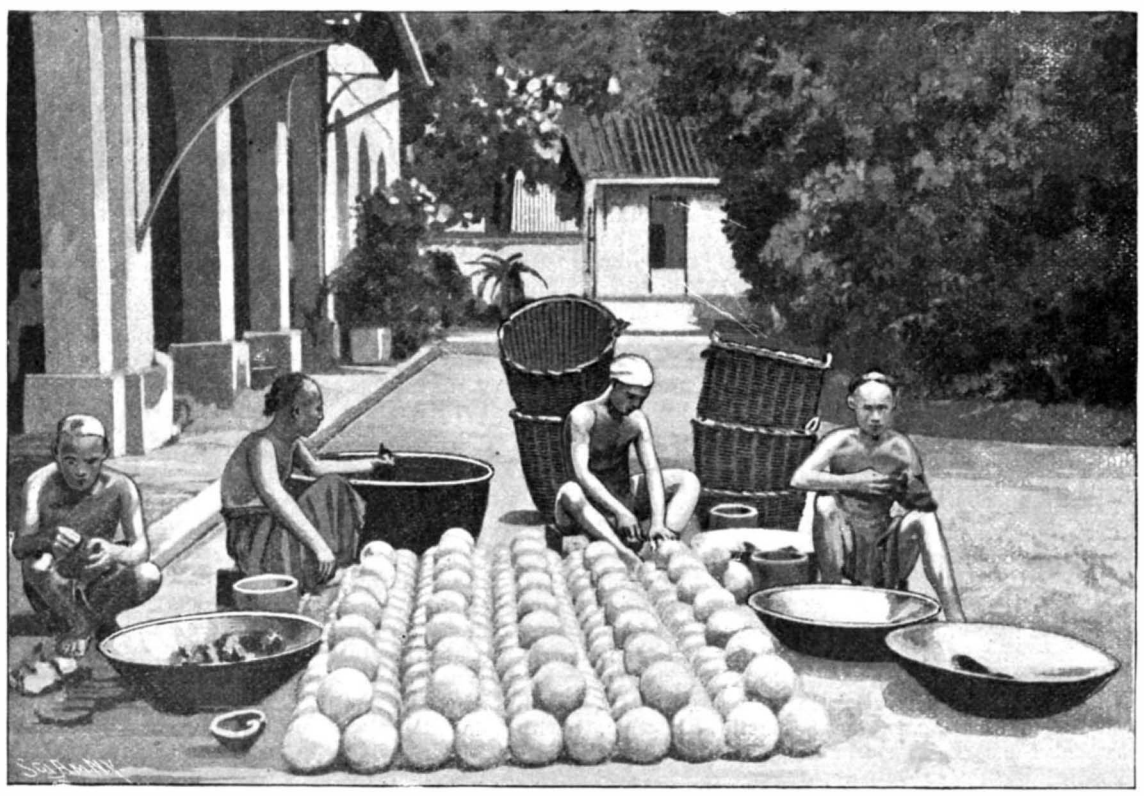
A new wonder of science has been revealed. Through the agency of these microscopic organisms, 10,000,000 of which can be held in a thimble, it is now believed to be perfectly practicable to draw from the 38,000 tons of nitrogen that, it is estimated, are suspended over every acre of land, an abundance of the most vital element of plant food, thereby greatly increasing the yield of crops and adding permanent fertility to the soil.

THE MORPHOLOGICAL METHOD AND PROGRESS.*

By Prof. G. B. HOWES, D.Sc., LL.D., F.R.S.

IT is now twenty-eight years since this Association last assembled in Belfast, and to those present who can recall the meeting the proceedings of Section D will be best remembered for the delivery of an address by Huxley "On the Hypothesis that Animals are Automata, and its History," one of the finest philosophic products of his mind. At that date the zoological world was about to embark on a period of marked activity. Fired by the influence of the "Origin of Species," which had survived abuse and was taking immediate effect, the zoological mind, accepting the doctrine of evolution, had become eager to determine the lines of descent of animal forms. Marine observatories were in their infancy; the "Challenger" was still at sea; the study of comparative embryology was but then becoming a science; and when, reflecting on this, we briefly survey the present field, we can but stand astonished at the enormity of the task which has been achieved.

Development has proceeded on every hand. The leavening influence, spreading with sure effect, has in due course extended to the Antipodes and the East, in each of which portions of the globe there has now arisen a band of earnest workers pledged to the investigation of their indigenous fauna, with which they are proceeding with might and main. Of the Japanese, let it be said that not only have they filled in gaps in our growing knowledge, for which they alone have the materials at hand, but that, with an acumen deserving the highest praise, they have put us right on first principles. I refer to the fact that they have shown, with respect to the embryonic membranes of the common chick, that we in the West, with our historic associations, our methods, and our skill, contenting ourselves with an ever-recurring restriction to the germinal area, have, by an error of orientation, missed an all-important septum, displaced under an inequality of growth.



OPENING THE OPIUM BALLS.

Those of us who have lived and worked throughout this memorable period have had a unique experience, for never has there been progress so rapid, accumula-

* Address before the British Association.

tion of observations so extensive and exact. Of the 386,000 living animal species, to compute the estimate low, every one available has been laid under hand, with the result that our annual literary output now amounts to close upon 10,000 contributions, the description of new genera and subgenera, say 1,700. More than one-half of this vast series refers to the Insecta alone; but notwithstanding this, the records of facts of structure and development, with which most of us are concerned, now amount to a formidable mass, calculated to awe the unlettered looker-on, to overwhelm the earnest devotee, unless by specializing he can secure relief. As an example of what may occur, it may be remarked that a recent exploration of the great African lakes has resulted in the discovery of over 130 new species.

As to the nature of this unprecedented progress, it will suffice to consider the Earthworms. In 1874 few were known to us. An advance in our knowledge, which had then commenced, had made known but few more which seemed likely to yield result. Darwin's book upon them had not appeared. Some were exotic, it is true, but no one suspected that a group so restricted in their habits could reveal aught beyond a dull monotony of form and structure. Never was surmise more wide of the mark, for the combined investigations of a score of earnest workers in all parts of the world have in the interval recorded some 700 odd species of about 140 genera. Mainly exotic, they exhibit among themselves a structural variation of the widest possible range. Not only do we recognize littoral and branchiate forms, but others achætous and leech-like in habit, to the extent of the discovery of a morphological overlap with the leeches, under which we are now compelled to remove them from their old association with the flat worms, and to unite them with the earthworms. And we even find these animals, as represented by the Acanthodrilidæ, coming prominently into considerations which involve the theory of a former Antarctic continent, one of the most revolutionary zoo-geographical topics of our time.

This case of the earthworm may be taken as typical of the rest, since for each and every class and order of animal forms, the progress of the period through which we have passed since last we assembled here has produced revolutionary results. Our knowledge of facts has become materially enhanced; our classifications, at best but the working expression of our ideas, have been to a large extent replaced in clearer, more comprehensive schemes; and we are to-day enabled to deduce, with an accuracy proportionate to our increased knowledge of fact, the nature of the interrelationships of the living forms which with ourselves inhabit the earth.

Satisfactory as is this result, it must be clearly borne in mind that its realization could not have come about but for a knowledge of the animals of the past; and turning now to palæontology, it may be said that at the time of our last meeting in this city the scientific world was just becoming entranced by the promise of unexpected results in the exploration of the American Tertiary beds, then being first opened up. The Rocky Mountain district was the area under investigation, and with this, as with the progress in our knowledge of recent forms, no one living was prepared for the discoveries which shortly came to pass. To consider a concrete case, we may premise that study of the placental mammals had justified the conclusion that their ancestors must have had equal and pentadactyle limbs, a complete ulna and fibula, a complete clavicle, and a skull with forty-four teeth; must have realized, that is, the predominant term of the living Insectivora as generally understood. Who among the zoologists of our time does not recall with enthusiasm the revelation which arose from the discovery, during these early days, in the Eocene of Central North America, of the genera at first described as Eo- and Helohyus? The evidence of the existence, in the locality named, of these forty-four-toothed peccaries, as they were held to be, rendered clearer the records of the later Tertiary deposits of the old world, which were those of hogs, and, in correlation with the facts then known, suggested that the Rocky Mountain area was the home of the ancestral porcine stock, and that in Early Tertiary times their descendants must have migrated, on the one hand, across the northern belt, of which the Aleutian Islands now mark the course, into the old world, to beget, by complication of their teeth, the pigs and hogs; and on the other into Central South America, to give rise, by numerical reduction of teeth and toes, to the peccaries, still extant.

Migration in opposite directions with diversity of modification was the refrain of this remarkable find, far-reaching in its morphological and zoo-geographical effects. Nor can we allude with less fervor to the still more striking case of the horses, which proved not merely a similar, though perhaps a later, migration, but a parallelism of modification in both the old and new worlds, culminating in the latter in extinction, whereby it became necessary, on the advent of civilized man, to carry back the old-world horse to its ancestral American home. No wonder that this should have provoked our Huxley to the remark that in it we have the "demonstrative evidence of the occurrence of evolution," and that the facts of palæontology came to be regarded as certainly not second to those of the fascinating but seductive department of embryology, at the time making giant strides.

I have endeavored thus to picture that state of zoological science at the time of our last meeting here; and I wish now to confine myself to some of the broader results since achieved on the morphological side. But let us first digress, in order to be clear as to the meaning of this phrase.

We do not expect the public to be accurate in their usage of scientific terms; but it is to me an astounding fact that among trained scientific experts, devotees to branches of science other than our own, there exists a gross misunderstanding as to the limitations of our departments. I quote from an official report in alluding to "comparative anatomists, or biologists, as they call themselves," and I but cite the words of an eminent scientific friend, in referring to biology and botany as coequal. In endeavoring to get rid of this prevailing error, let it be once more said that the term "biology" was introduced at the beginning of the nineteenth century by Treviranus and Lamarck, and that in its usage it has come to signify two totally distinct things as employed by our continental contemporaries and ourselves. By "biologie" they understand the study of the organism in relation to its environment. We, following Huxley, include in our term "biology" the study of all phenomena manifested by living matter—botany and zoology; and by morphology we zoologists mean the study of structure in all its forms, of anatomy, histology and development, with palæontology—of all, that is, which can be preferably studied in the dead state, as distinct from physiology, the study of the living in action. Comparative morphology, the study of likeness and unlikeness, is the basis of our working classifications, and it is to the consideration of the morphological method, and the more salient of its recent results, that I would now proceed, in so far as it may be said to have marked progress and given precision to our ideas within the last eight-and-twenty years. I would deal in the main with facts, with theories only where self-evident, ignoring that type of generalization to which the exclusive study of embryology has lent itself, which characterizes, but does not grace, a vast portion of our recent zoological literature.

To the earnest student of zoology, intent on current advance, the mental image of the interrelationships of the greater groups of animal forms is ever changing, kaleidoscopically it may be, but with diminishing effect in proportion as our knowledge becomes the more precise.

Returning now to American palæontology, we may at once continue our theme. In this vast field, expedition after expedition has returned with material rich and plentiful; and while, by study of it, our knowledge of every living mammalian order, to say the least, has been extended, and in some cases revolutionized, we have come to regard the Early Tertiary period as the heyday of the mammals, in the sense that the present epoch is that of the smaller birds. No wonder then that there should have been discovered group after group which has become extinct, or evidence that in matters such as tooth-structure there is reason to believe that types identical with those of to-day have been previously evolved but to disappear. To contemplate the discovery of the Titanotheria, the Amblyopoda, the Dinocerata, with their strange diminutive brain, chief among the heavier ungulate forms, is to consider the Mammalia anew; and when it is found that among late discoveries we have (1) that of a series of Rhinoceratoidea, which though not yet known to extend so far back in time as the primitive tapirs and horses are complete as far as they go; (2) that among the Ruminants we have, in the Oreodontidæ of the American Eocene, primitive forms with a dentition of forty-four teeth, and absence of diastemata, a pentadactyle manus, a tetradactyle pes with traces of a hallux, and, as would appear from an example of Mesoreodon, a bony clavicle, such as is unknown in any later ungulate, we are aroused to a pitch of eager enthusiasm as to the outcome of labors now in hand; for, as I write, there reaches me a letter to the effect that for most of the great vertebrate groups, and not the mammals alone, collections are still coming in, each more wonderful than the last.

In the extension of our knowledge of the Ancylopoda, an order of mammals named after the Ancylotherium of Pikermi and Samos, which occur in the Early Tertiary deposits of Europe, Asia, North America and abundantly in Patagonia, we have been made aware of the existence of genera whose salient structural features combine the dentition of an ungulate with the possession of pointed claws, believed to have been retractile like those of the living cats. Conversely to these unguiculate herbivores, which include genera with limbs on both the artio- and perisso-dactyle lines, there have been found, among the so-called Mesonychidæ, undoubted primitive carnivores, indications of a type of terminal phalanx seal-like and approximately non-unguiculate; from all of which it is clear that we have in the rocks the remains of forms extinct which transpose the correlations of tooth and claw deducible from the living orders alone. Further, among the primitive pentadactyle Carnivora we meet in the genus Patriofelis with a reduction of the lower incisors to two, and characters of the fore-limb which, with this, suggest the seals. It is, however, probable that these characters are in no way indicative of direct genetic relationship between the two, for, inasmuch as these animals were accustomed to seek their food in the waters of the lake by which they dwelt, their seal-like characters may be but the expression of adaptation to a partially aquatic mode of life—of parallelism of modification with the seals and nothing more.

Early in the history of their inquiry, our American confrères recorded from the Pliocene the discovery of camel-like forms possessed of a full upper incisor dentition; for example, the genera Protolabis and Ithygrammodon; and now they have arrived at the conclusion that while the camels are of American origin, one of their most characteristic ruminants, the prongbuck (Antilocapra), would conversely appear to be the descendant of an ancestor (Blastomeryx) who migrated from the old world.

Sufficient this concerning the work in mammalogy of the American palæontologists. While we return them our devout and learned admiration, we would point out that the brilliance of their discoveries has but beclouded the recognition of equally important investigations going on elsewhere. In Argentina there have proceeded, side by side with the North American explorations, researches into the Pleistocene or Pampa fauna, which in result are not one whit behind, as has been proved by the recognition of a whole order of primitive ungulates, the Toxodontia, by that of toothed cetaceans with elongated nasals, as in the genera Prosqualodon and Argyrocetus, and of sperm whales with functional premaxillary teeth, viz., Physodon and Hypocetus, to say nothing of giant armadillos and pigmy glyptodons.

It will be remembered by some present that, from Patagonian deposits of supposed Cretaceous age, there was exhibited at our Dover meeting the skull of a horned chelonian Meiolania, which animal, we were informed, is barely distinguishable from the species originally discovered in Cook's Island, one of the Society group, and which, being a marsh turtle highly specialized, would seem in all probability to furnish a forcible defense for the theory of the Antarctic continent. But more than this, renewed investigation of the Argentine beds by the members of the Princeton University of North America have recently resulted in collections which, we are informed, seem likely to surpass all precedent in their bearings upon our current ideas, not the least remarkable preliminary announcement being the statement that there occurs fossil a mole indistinguishable, so far as is known, from the golden mole (Chrysochloris) of South Africa.

Before I dismiss this fascinating subject, let me disarm the notion, which may have arisen, that the palæontological work of the old world is done. Far from it! Even our American cousins have to come to us for important fossil forms; as, for example, the genus Pliohyrax of Samos and the Egyptian desert, while among the rodents and smaller carnivores there are large collections in our national museum waiting to be worked over afresh.

If one part of the globe more than another is just now the center of interest concerning its vertebrate remains, it is the Egyptian desert. Here there have recently been found the bones of a huge cetacean associated, as in South America, with those of a giant snake, one of the longest known, since it must have reached a length of thirty feet. There also occur the remains of other snakes, of chelonians of remarkable adaptive type, of crocodilians, fishes, and other animals. Interest, however, is greatest concerning the Mammalia, which for novelty are quite up to the American standard, as with an upper and a lower jaw of an anomalous creature, concerning which we can only at present remark that it may be a marsupial, or more probably a carnivore, which has taken on the rodent type in a manner peculiarly its own. Important beyond this, however, are a series of Eocene forms which more than fill a long-standing gap, viz., that of the ancestors of the Elephants and Mastodons, which hitherto stopped short in the Middle Miocene of both old and new worlds. As represented by the genus Mæritherium, they have three incisors above and two below, of which the second is in each case converted into a short but massive tusk. An upper canine is present, and in both upper and lower jaws a series of six cheek-teeth, distinct and bunodont in type. In the allied Barytherium, of which a large part of the skeleton is known, the upper incisors were presumably reduced to two, the tusks enlarged, with resemblances in detail to the Dinoceratan type.

So far as these remains are known, they appear to present in their combined characters all that the most ardent evolutionist could desire. There are with them Mastodons which simplify our knowledge of this group; and among the last discovered remains Sirenians, which, in presenting a certain similarity to the aforenamed Mæritherium, strengthen the belief in the proboscidian relationships of these aquatic forms. Finally, and perhaps most noticeable of all, there is the genus Arsinoitherium, a heavy brute with an olfactory vacuity which outrivals that of Grypotherium itself, and is surmounted by a monstrous fronto-nasal horn, swollen and bifid, for which the most formidable among the Titanotheres might yearn in vain. There is an occiput to match! The suggestion that this extraordinary beast has relationships with the Rhinoceridæ is absurd, since its tooth pattern alone inverts the order of this type. That it is a proboscidian may be nearer the mark, and if so it shows once more how subtle were the mammals of the past. Great as is this result, much remains to be done or done again, if only from the fact that in seeking to determine homologies our American brethren, in the opinion of some of us, have placed too much reliance on a so-called tritubercular theory of tooth genesis, of which we cannot admit the proof. How, we would ask, is it conceivable that a transversely ridged molar of Diprotodon type can be of tritubercular origin?

Sufficient for the moment of palæontological advance, except to remark that the zoologist who neglects this branch of morphology misses the one leavening influence; neglects the court on whose ruling arguments deduced from embryological data alone must either stand or fall. We may form our own conclusions from facts of the order before us; but it is when we find their influence on the master mind prompting to action, like that of Huxley with his mighty memoir of 1880, in which he revised our subclass terms, that we appreciate them to the full.

With this consideration we pass to the living forms, and I have only time in dealing with these to comment on advance which affects our broadest conceptions and classifications of the past.

To commence with the Mammalia, we now know that the mammary gland when first it appears is in all forms tubular, and that this type is no longer distinctive of the Monotremata alone. We know, too, that the intranarial position of the epiglottis when at rest, long known for certain forms, is a distinction of the class. It explains the presence of the velum palatinium, by its association with the glottis for the restriction of the respiratory passage, the connection being lost in man alone, under the specialization of the organ of the voice.

Similarly, the doubly ossified condition of the coracoid may now be held diagnostic, for it is known that the epicoracoidal element, originally thought to characterize the monotremes alone, is always present, and that reduction to a varying degree characterizes the metacoracoid, which retires, as in man, as the so-called coracoid epiphysis.

Our conceptions of the interrelationships of the Marsupialia and Placentalia have during the period we are considering been delimited beyond expectation, by the discovery of an allantoic placenta in a polyprotodont marsupial, in place of the vitelline, present in its allies. When it is remembered that in the formation of the placenta of the rabbit and a bat there is realized a provisional vitelline stage, it is tempting to suggest that the evidence for the direct relationship of the two mammalian subclasses first named overlaps (there being a placental marsupial on the one hand, a marsupial placental on the other), much as we have come to regard Archæapteryx as an avian reptile, the Odontornithes as reptilian birds. These facts, moreover, prove that the type of placenta inherited by the Placentalia must have been discoidal, and that from that all others were derived.

Equally important concerning our knowledge of the Marsupialia is the discovery, first made clear by Prof. Symington, of this college, that Owen was correct in denying them a corpus callosum. How Owen arrived at this conclusion it is difficult to conceive; but in these later days the history of discovery is largely that of method; and it is by the employment of chrome-silver, methylene-blue, and other reagents, which in differentiating the fiber-tracts enable us to delimit their course, that this conclusion has been proved. By the corpus callosum we now understand a series of neo pallial fibers which transect the alveus and are present only in the Placentalia.

There is no department of mammalogy in which recent work has been more luminous than this which concerns the brain; and, to mention but one result, it may be said that in the renewed study of the commissures there has been found a fiber-tract characteristic of the Diprotodontia alone, so situated as to prove that they and the Placentalia must have specialized on diverse lines from a polyprotodont stock. Interesting this, the more, since the phalangers and kangaroos are known to be polyprotodont when young. And when we add the discovery that in the detailed relationship of its commissures the brain of the Elephant Shrew, a lowly insectivore, alone among that of all Placentalia known, realizes the marsupial state, as does its accessory organ of smell, we have to admit the discovery of annectant conditions just where they should occur.

The morphological method is sound!

The master hand which has given us this result has also reinvestigated the Lemurs. From an exhaustive study of the brain or its cast of all species, of the order, living and extinct, there has come the proof that the distinctive characters of the lemuroid brain are intelligible only on a knowledge of the pithecoid type; that its structural simplicity in the so-called lower lemurs is due to retrogressive change, in some species proved to be ontogenetic; and that the Tarsier, recently claimed to be insectivore, is a lemur of lemurs. It is impossible to overestimate the importance of this conclusion, which receives confirmation in recent palæontological work; and there is demanded a reinvestigation of those early described Tertiary fossil forms placed on the Ungulo-lemuroid border line, as also a reconsideration of current views on the evolution of the primates and of man.

In dismissing the Mammalia, we recall the capture during the period we review of three new genera, a fourth, the so-called Neomylodon, having proved by its skull to be *Grypotherium darwinii*, already known, The African Okapi, an object of sensation beyond its deserts, has found its place at last. To have been dubbed a donkey, a zebra, and a primitive hornless giraffe is distinction indeed; and we cannot refrain from contrasting the nonsensical statement that its discovery is "the most important since Archæapteryx" with the truth that it is a giraffine, horned for both sexes, annectant between two groups known. As a discovery it does not compare with that of the Mole-marsupial, and it falls into insignificance beside that of the South American diprotodont Cœnolestes, the survivor of a family which there flourished in Middle Tertiary times.

Passing to birds and reptiles, it will be convenient to consider them together. A knowledge of their anatomy has extended on all hands, and in respect to nothing more instructively than their organs of respiration. Surprise must be expressed at the discovery, in the chelonian, of a mode of advancing complication of the lung suggestive of that of birds. On looking into this, I find that Huxley, who rationalized our knowledge of the avian lung and its sacs, was aware of the fact that in our common water-tortoise (*Emys orbicularis*), the lung is sharply differentiated along the bronchial line into a postero-dorsal more cellular mass, an antero-ventral more saccular, of which the posterior vesicle, in its extension and bronchial relationships, strangely simulates the so-called abdominal sac of birds. He had already instituted comparison with the crocodiles, and was clearly coming to the conclusion that the arrangement in the bird is but the result of extreme specialization of a type common to all Sauropsida with a "cellular" lung. The respiratory process in the bird may be defined as transpulmonary, and it is an interesting coincidence that, as I write, there comes to hand a memoir, supporting Huxley's conclusion, and establishing the fact that there is a fundamental principle underlying the development and primary differentiation of all types of vertebrate lung.

The discovery of the Odontornithes in the American Cretaceous is so well known, that it is but necessary to remark that nine genera and some twenty species are recognized. To Archæapteryx I shall return. Before dismissing the Chelonia, however, it must be pointed out that palæontology has definitely clenched their supposed relationship to the Plesiosaurs. Of all recent palæontological collections there are none which, for care in collecting and skill in mounting, surpass the reptilian remains from the English Jurassic (Oxford Clay) now public in our national museum. The Plesiosaurs of this series must be seen to be appreciated, and nothing short of a merciful Providence can have interposed, to insure the generic name Cryptocleidus, which one of them has received, since the hiding of the clavicle, its diagnostic character, is an accomplished fact. It is due to secondary displacement, under the approximation in the middle line of a pair of proscapular lobes, present in the Plesiosauria and Chelonia alone, and until the advent of this discovery misinterpreted. Taken in conjunction with other characters of little less importance, conspicuously those of the plastron and pelvis, this decides the question of affinity, and proves the Chelonia to have had a lowly ancestry, as has generally been maintained.

Recent research has fully recorded the facts of development of the rare New Zealand reptile Sphenodon, and it has more than justified the conclusion that it is the sole survivor of an originally extensive and primitive group, the Rhynchocephalia, as now understood. To confine our attention to its skeleton, as that portion of its body which can alone be compared with both the living and extinct, it may be said that positive proof has been for the first time obtained that the developing vertebral body of the terrestrial vertebrata passes through a paired cartilaginous stage, and that in its details the later development of this body is most nearly identical with that of the lower Batrachia. There has long been a consensus of opinion that the forward extension of the pterygoids to meet the vomers in the middle line, known hitherto in this animal and the crocodiles alone, is for the terrestrial vertebrata a primitive character; and proof of this has been obtained by its presence in all the Rhynchocephalia known. The same condition has also been found to exist in the Plesiosaurs, the Ichthyosaurs, the Pterodactyles, the Dicynodontia, the Dinosaurs, and with modification in some Chelonians. It has, moreover, been found in living birds; a most welcome fact, since Archæapteryx, in the possession of a plastron, carries the avian type a stage lower than the Dinosaurs. It is pertinent here to remark that, inasmuch as in those Dinosaurs (e. g. Compsognathus) in which the characters of the hind limbs are most nearly avian, the pelvis, in respect to its pubis, is at the antipodes of that of all known birds, and the fore limb is shortened in excess of that of Archæapteryx itself, the long supposed dinosaurian ancestry for birds must be held in abeyance.

Passing through the Rhynchocephalia to the Batrachia, we have to countenance progress most definite in its results. The skull, the limbs, and their girdles are chiefly concerned, and this in a very remarkable way.

In the year 1881 there was made known by Prof. Froriep, of Tübingen, the discovery that the hypoglossus nerve of the embryo mammal is possessed of dorsal ganglionated roots. Again and again have I heard Huxley insist on the fact that the ventral roots of this nerve are serial with the spinal set, but never did he suspect the rest. It is, however, a most intensely interesting fact that, whereas by a Huxleian triumph the vertebral theory of the skull was overthrown, in these later Huxleian days the proof of the incorporation of a portion of the vertebral region of the trunk into the mammalian occiput should have marked the succeeding epoch in advance. The existence of twelve pairs of cranial nerves which all the Amniota possess involves them in this change; and the fact that in all Batrachia there are but ten, enables us to draw a hard-and-fast line between batrachian and amniote series.

It may be urged, as an objection, that since we have long been familiar with a fusion of vertebræ and skull in various piscine forms, the force of this distinction is weakened. But this cannot be; since, in respect to the investing sheaths and processes of development which lie at the root of the genesis of the vertebral skeleton, the fishes stand distinct from the Batrachia and Amniota, which are agreed. So forcible is this consideration that it behooves us to express it in words and I have elsewhere proposed to discriminate between the series of terrestrial vertebrata as *archae* and *syncraniate*.

Similarly there is no proof that any batrachian, living or extinct (and in this I include the Stegocephala as a whole) possesses a costal sternum. So far as their development is known, the cartilages in these animals called "sternal" are either coracoidal or *sui generis*. The costal sternum, like the syncraniate skull, is distinctive of the Amniota alone. Had the Stegocephala possessed it even in cartilage, there is reason to think it might have been preserved, as it has been in the colossal Mososaur Tylosaurus of the American Cretaceous. When to this it is added that whereas, in the presence of a costal sternum, the mechanism of inflation of the lung involves the body-wall, in its absence it mainly involves the mouth (as in all fishes and batrachians), the hard and sharp line between the Batrachia and Amniota may be expressed by the formula that the former are *archaecraniate* and *stomatophysous*, the latter *syncraniate* and *stomatophysous*.

There are allied topics which might be considered did our time permit; but one certain outcome of this is that there is an end to the notion of a batrachian ancestry for the Mammalia. And when, on this basis, we sum up the characters demanded of the stock from which the Mammalia have been derived, we find them to be precisely those occurring outside the Mammalia in the Anomodont reptiles alone. Beyond the sternum and skull, the chief characters are the possession of short and equal pentadactyle limbs, with never more than three phalanges to a digit, a complete fibula and clavicle, a doubly ossified coracoid, a heterodont dentition—a combination which, wholly or in part, we now associate with the Permian genera Procolophon, Pariasaurus, and others which might be named, the discovery of which constitutes one of the morphological triumphs of our time.

Beyond this, it may be added, concerning the Batrachia, that among living pedate forms the Anura have alone retained the pentadactyle state and the complete maxillo-jugal arch, and that the Eastern Tylototriton, in the possession of the latter, becomes the least modified urodele extant. These facts lead to the extraordinary conclusion that the living Urodela, while of general lowly organization, are one and all aberrant; and it is not the least important sequel to this that, despite their total loss of limbs, the Apoda, in the retention of the dermal armor and other features which might be stated, are the most primitive Batrachia that exist.

The batrachian phalangeal formula 22343 was until quite recently a difficulty in the determination of the precise zoological position of the class; but it has now been overcome, by the discovery of a Keraterpeton in the Irish Carboniferous having three phalanges on the second digit of both fore and hind limbs, and by that in the Permian of Saxony of a most remarkable creature, Sclerocephalus, which, if rightly referred to the Stegocephala, had a head incased, as its name implies, in an armature like that of a fish, and the phalangeal formula of a reptile, 23454.

Passing from the Batrachia to the fishes, we have still to admit a gap, since an interminable discussion on fingers and fins has not narrowed it in the least. In compensation for this, however, we have to record within the fish series itself progress greater, perhaps, than with the higher groups. Certainly is this the case if, as to bulk, the literature in systematics and palæontology be alone taken into account.

Of the Dipnoi our knowledge is fast becoming complete. We know that Lepidosiren forms a burrow; and, in consideration of a former monstrous proposal to regard this animal, with its fifty-six pairs of ribs, and Protopterus, with its thirty to thirty-five, as varieties of a species, it is the more interesting to find that the Congo has lately yielded a Protopterus (*P. Dolloi*) with the lepidosiren rib formula, viz., fifty-four pairs.

As a foremost result of American palæontological research we have to record the occurrence, in the Devonian of Ohio, of a series of colossal fishes known as the Arthrodira, the supposed dipnoan affinities of which are still a matter of doubt.

We have evidence that the osseous skeleton in a plate-like form first appeared as a protection for the eye of a primitive shark. And coming to recent forms having special bearings on the teachings of the rocks, we have to acknowledge the capture in the Japanese seas of a couple of ancient sharks, of which one (Cladoselachus), since observed to have a distribution extending to the far north, is a survivor from Devonian times; the other (Mitsukurina) a genus whose grotesqueness leaves no doubt of identity with the Cretaceous lamnoid Scapanorhynchus. In the elucidation of the Sturiones and the determination of their affinities with the ancient Palæoniscidæ a master stroke has been achieved. In the Old Red genus Palæospondylus we have become familiar with an unmistakable marsipobranch, possessing, as do certain living fishes, a notochord, annulated, but not vertebrated in the strict sense of the term. The climax in Ichthyopalæontology, however, has been reached in the discovery of Silurian forms, which, there is every reason to believe, explain in an unexpected way the hitherto anomalous Pterasand Cephalaspidians, by involving them in a community of ancestry with the primitive Elasmobranchs The genera Thelodus, Drepanaspis, Ateleaspis, and Lanarkia chief among these annectant and ancestral forms, are among the most remarkable vertebrate fossils known.

(To be continued.)

The Pennsylvania Steel Company is working on an order of 3,400 tons of steel rails for the Pennsylvania Railroad, which will weigh 140 pounds to the yard. These rails will be used in tracks laid in the streets of Philadelphia. They are girder rails, made exceptionally heavy for carrying the heaviest freight cars and engines, and at the same time are in accordance with regular street car specifications. They are 9 inches in height.

STABILITY TESTS FOR NITROCELLULOSE AND NITROCELLULOSE POWDERS.*

By ALBERT P. SY, M. S., Assistant Chemist, Ordnance Department, U. S. Army, Frankford Arsenal.

STABILITY tests, sometimes also called "heat tests," are applied to explosives to determine their keeping qualities, or chemical stability. The manufacturer also uses some stability tests, during manufacture, to determine if his product has been thoroughly purified.

That the stability of an explosive is of the utmost importance must be apparent, and it explains why government and explosives chemists have been and are making an exhaustive study of the methods for stability testing. Although a great deal of work has been done in this direction yet the best methods in use to-day are still far from ideal. The fault lies in the fact that the general cause or causes of instability of explosives have not been established.†

In the early stages of nitro-explosives manufacture, instability was frequently caused by traces of nitrating acids left in the finished product. To-day, with improved methods and apparatus, insufficient purification is not the most frequent cause of instability. But, even if purification be perfect, it has been found‡ that normal products perfectly purified may become unstable.

Among the known causes of instability are the following:

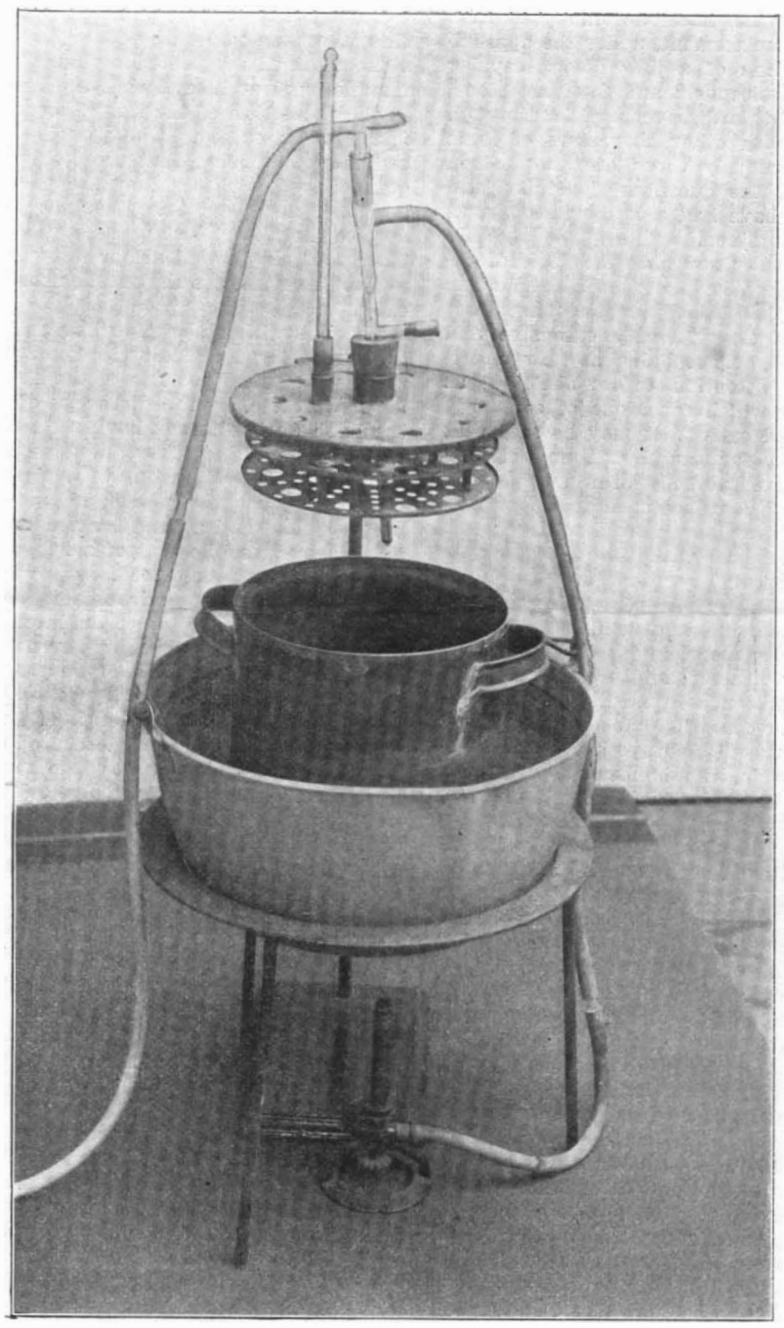


FIG. 1.—APPARATUS FOR KI-STARCH TEST.

(1) Traces of nitrating acids left carelessly by the manufacturer. (Rare.)

(2) Substances added to powders to increase stability sometimes have the reverse effect. For example, alkalies, added to powders for the purpose of neutralizing traces of nitrating acids or acids which might be formed from decomposition of an unstable powder, may cause saponification or decomposition of the nitrocellulose itself. The value of alkalies for increasing stability is a disputed point.§ Saponification may be caused by water. A sample of pure nitroglycerin kept in distilled water has been known to develop acidity.‖

(3) Local decomposition may be set up in a powder by careless treatment and handling.

(4) Exposure to higher than usual temperatures, during drying or storing.

(5) Cotton wool always contains, even after careful cleaning, small quantities of organic substances other than cellulose.¶ These are nitrated together with the cellulose, forming nitro-compounds which are quite unstable; they can not be removed by ordinary processes of washing or solution.* These unstable compounds may cause decomposition of the nitrocellulose.

(6) Various investigators† hold that even a perfectly pure product may decompose slowly, spontaneously; the products of such decomposition may act catalytically and thus bring about complete decomposition. According to this view all nitrocelluloses are unstable, or their degree of stability is only relative, depending upon conditions.

(7) Spontaneous combustion of organic compounds is believed to be caused by intramolecular respiration or oxidation, and it seems likely that this might be the cause of spontaneous decompositions of nitrocellulose, even if it be perfectly pure. The nitrocellulose molecule is comparatively large and the atoms loosely held together, which would favor decomposition brought about by internal oxidation. The difference in stableness of different nitrocelluloses could easily be explained by slight differences in composition, preparation, handling, and differences in physical properties.

It has been stated‡ that it does not follow that because two substances are stable, a mixture of the two will also be stable; e. g., a stable nitrocellulose and a stable nitroglycerin when mixed may produce an unstable mixture; in such cases, the mixture is undoubtedly more liable to internal oxidation than are the ingredients before mixing.

(8) It does not seem unlikely that denitrifying bacteria might start a decomposition of nitrocellulose, and preliminary experiments strongly indicate the probability of such decomposition. The possibility of bacteria causing a decomposition and consequently instability of nitrocellulose is conceded (private communications to the writer) by authorities on the subject of denitrifying bacteria. These experiments are to be continued at this laboratory.

Stability tests are always made on explosives at higher than ordinary temperatures of storage. This is done in order to shorten the time required for obtaining results, it having been determined by experiments that the stability of a powder or nitrocellulose decreases as the temperature to which it is exposed increases.§ For each method of testing stability it is necessary to know the behavior of a good or standard powder with which to compare results obtained from other powders. On account of the great influence of slight variations in apparatus, reagents or manipulations in making stability tests, the results obtained by any one test, but by different operators, seldom agree.

Following is a brief description of the more important stability tests now in general use; four of these are used officially at this laboratory. None of these tests are entirely satisfactory, as will be seen later. There is also given a description of a new test, developed at this laboratory; this test has been applied to a large number of powders, and has given entirely satisfactory results.

THE POTASSIUM-IODIDE STARCH, OR ABEL TEST.*

This is the oldest and most extensively used stability test for finished products, as well as a purity test used by the manufacturer. It is one of the official tests of the Ordnance Department, U. S. Army, prescribed† and made as follows: The sample is prepared by cutting into slices 0.02 inch thick, and then exposed to the air for at least 12 hours.‡

In testing nitrocellulose, air-dried samples are taken. 1.3 grm. is placed in a test tube (6 x ½ inch) which is then closed by a cork carrying a glass rod, the latter having a hook of platinum wire fused in at the lower end. On this hook there is suspended a strip of KI-starch paper, moistened to one-half its length with a 50 per cent. glycerin solution. The position of the test paper in the tube is so adjusted that the line dividing the dry and wet portions of the paper is on a level with the lower edge of the film of moisture expelled from the explosive and deposited on the inside of the tube. The tube is immersed in a bath, the temperature of which is regulated to 65.5 deg. C. (±1 deg.) for nitrocellulose and to 100 deg. C. (±1 deg.) for smokeless powders (nitrocellulose powders). The bath consists of an open water bath in which there is placed a copper vessel containing water or glycerin; the copper vessel has a cover consisting of three perforated and parallel disks about one inch apart. The holes in the upper and middle disks are just large enough to admit the test tubes, while those in the lower disk are smaller. This arrangement serves to hold the tubes all at the same level and in a vertical position and is an improvement over the old form of apparatus usually used in this test.

When the bath has reached the required temperature the tubes with the samples are immersed, and the test begins at this moment; it ends at the appearance of a brown line on the test paper at the juncture of the dry and wet portions. For a good nitrocellulose this discoloration must not take place in less than forty minutes (at 65.5 deg. C.) and not less than ten minutes (at 100 deg. C.) for a good nitrocellulose powder. Powders containing nitroglycerin should stand this test for twenty minutes at 65.5 deg. C. The discoloration of the test paper is due to the action of free iodine on the starch, the iodine being liberated from the KI by impurities, or products of decomposition§ volatilized from the explosive.

This test as described, or with some slight modifications, is more extensively used than any other. However, it is of most value to the manufacturer, since by careful application of the test he can determine whether his products are thoroughly purified, and the test could be called a "purity test" more appropriately than a "stability test." When applied to finished products, this test has many weak points, as follows:

(1) It shows, in cases of decomposition of the sample during the test, only the beginning and not the continuation of the decomposition.‖

(2) Traces of unstable nitro-compounds (other than nitrocellulose) would show a product in which they are found by this test to be bad; yet these traces of comparatively unstable compounds might not cause a decomposition of the explosive if kept under ordinary conditions. And, considering that there is no indication as to the effect of these traces of unstable compounds, this test does not indicate the keeping qualities of the explosive.

(3) In cases of nitrocellulose powders, this test is affected by the solvents used in making the powders.

(4) The weakest point of this test is that it can be masked by a number of substances which are sometimes added to the explosive for this purpose. Mercury salts, especially mercuric chloride, are most frequently used for this purpose.¶ According to Thomas,** $HgCl_2$ is reduced to Hg which unites with the oxides of nitrogen, preventing volatilization of the latter, and consequently retards the action on the test paper. A test paper which shows discoloration is readily bleached when exposed to vapors of mercury. Samples of nitrocellulose have been received at this laboratory which contained traces of metallic mercury, which had been added as such, or had been reduced from a mercury salt.

Amines, e. g., urea, have been added to powders in order to mask or lengthen the stability test.†† Amines react with nitrous fumes as follows:

$$R.NH_2 + HONO = R.OH + N_2 + H_2O.$$

* From Journal of the United States Artillery.
† Luck & Cross. Jour. Soc. Chem. Ind., 1900, p. 642.
‡ Guttmann: Zeitschr. f. Angew. Ch 1897, p. 233.
§ Guttmann: Zeitschr. f. Angew. Ch. 1897, p. 233.
‖ Thomas: Zeitschr. f. Angew. Ch. 1899, p. 55.
¶ Abel: Trans. Roy. Soc., 1866, p. 307.

* Luck & Cross: Jour. Soc. Ch. Ind., 1900, p. 642.
† Hoitsema: Zeitschr. f. Angew. Ch. 1899, p. 705. Luck & Cross: Jour. Soc. Ch. Ind. 1900, p. 642.
‡ Guttmann: Zeitschr. f. Angew. Ch. 1897, p. 233.
§ Sy: Jour. Am. Ch. Soc., June, 1903, p. 562.

* Trans. Roy. Soc., 1866, p. 269.
† "Standard Methods of Chemical Tests of Nitrocellulose, etc." Ord. Dept., U. S. Army.
‡ Preliminary experiments indicate that better results can be obtained by this test if the samples are prepared by turning off thin shavings in a lathe and exposing to air for 24 hours. In the Navy Department, the samples are prepared by shaving the powder with glass, producing very thin shavings, which are then exposed to 45 deg. C. for 48 hours, and then put in a moisture box over night.
§ Principally nitrogen oxides and acids.
‖ Will: Mittheilungen a. d. Centralstelle f. Wissenschaft. Unt rsuch. No. II. Dec., 1900.
¶ "The presence, in a powder, of mercuric chloride, or alkali, or any other substance which might in any way mask or interfere with the heat test (KI-starch) will be sufficient to cause its rejection." Standard Methods of Chem. Tests, Ordnance Dept., U. S. Army.
** Zeitschr. f. Angew. Chem., 1898, p. 1027.
†† Hoitsema: Zeitschr. f. Angew. Chem., 1899, p. 705.

Small quantities of alkalies or carbonates are sometimes added to neutralize remaining traces of nitrating acids, and also to combine with nitrous fumes resulting from decomposition.*

Other substances used to mask stability are† acetic ether, acetone, oils, vaseline, aniline.

(5) The test is affected by the condition of the sample,‡ size of grains or pieces, whether freshly prepared for testing or exposed to air, and by moisture content.

(6) Slight differences in test papers greatly affect the results of this test.§ The test papers used by the Ordnance Department are made in large quantities by Eimer & Amend, of New York, according to specifications, thereby insuring greater uniformity than if made at different laboratories in small quantities. Manufacturers who have contracts with the government are supplied with these test papers.

(7) The personal equation of the operator enters as a factor in causing variations. It is no easy matter to decide just when there is "the first appearance of a brown line" on the test paper, or just when the line is of the same intensity as a standard.

From what has been said, it must be apparent that this test has too many weak points to make it a reliable one. The Ordnance Department condemns no powder on results of this test alone.

THE ZINC-IODIDE STARCH TEST.

This is a modification of the test just described, using zinc iodide instead of potassium iodide, and a temperature of 80° deg. C.

Zinc iodide is more sensitive than potassium iodide,‖ and also acts as a preservative of the test paper. However, a greater sensitiveness is in no way an improvement of the KI-starch test, and results obtained at this laboratory show that it is no more reliable than the original, having all the weak points of the latter.

THE GUTTMANN DIPHENYLAMIN TEST.¶

Instead of using potassium or zinc iodide test papers, Guttmann recommended a paper moistened with a solution of diphenylamin in sulphuric acid. He claimed for his test the following advantages over the KI-starch test:

(1) Not as sensitive.
(2) Test papers more easily prepared.
(3) Masking substances do not interfere as much.

The temperature used is 70 deg. C., and nitrous fumes turn the colorless paper to a greenish-yellow and finally blue.

Thomas says** the diphenylamin test is unsatisfactory; it may be masked by adding diphenylamin to the explosive to be tested. Guttmann himself admits that the blue color sometimes fails to appear. Moisture in the sample affects the test. Thomas as well as others failed to get a sharp end reaction. The test was tried at this laboratory but gave unsatisfactory results and was discontinued. Thomas, Aspinwall,†† Spica,‡‡ found sufficient objections, after trial, to discard it. Major Nathan says§§ the test fails when testing volatile explosives, such as nitroglycerin, the latter being decomposed by the sulphuric acid on the test paper.

THE HESS TEST.‖‖

Hess heated nitrocellulose to 70 deg. C. in a tube, and, by means of a current of air, the volatile products of decomposition are carried into a dilute solution of KI-starch. Five observations are made: four colorimetric readings on the KI-starch solution, and the time required for explosion of the sample. This test shows the beginning, and roughly and for a short time also how decomposition proceeds. The KI-starch solution, like the KI-starch papers, is far too sensitive, and has the weak points mentioned under the "KI-starch test."

THE HOITSEMA TEST.¶¶

Another test in which an attempt is made to show the progress as well as beginning of decomposition. The explosive is heated for fifteen minutes at a constant temperature, and then, by means of a current of carbon dioxide, the volatile products of decomposition are passed through glass-wool moistened with Guttmann's diphenylamin solution. The operation is repeated, lowering the temperature 10 deg. each time until a temperature is found at which no decomposition takes place, i. e., at which no products of decomposition are formed which give a color reaction with the diphenylamin.

This test is subject to most of the objections mentioned under the previous tests, especially the Guttmann test. As far as the writer knows it is not in use in this country.

THE EXPLOSION TEST.

For this test 0.1 gramme of the explosive is placed in a strong, wide test tube, which is then lightly corked and placed in a paraffin bath at 100 deg. C. The bath is stirred and heated so that the temperature rises 5 deg. a minute until the sample explodes; the temperature at which this takes place is noted.

A good nitrocellulose should not explode under 186 deg. C.

A good nitrocellulose powder should not explode under 177 deg. C.

A good nitroglycerin powder should not explode under 170 deg. C.

Experience shows that this test is reliable when the explosive is either very good or very bad, and is only a rough guide as to stability. Variations in conducting the test give widely differing explosion points, especially if the temperature is raised at a different rate than 5 deg. a minute.

(To be continued.)

* The value of alkalies or carbonates for increasing stability is a disputed point. Guttmann (Zeitschr. f. Angew. Chem., 1897, p. 233) discourages this practice, contending that the real decomposition of a nitrocellulose soon develops more acid than can be neutralized by the small amount of added alkali. Under some conditions, alkalies saponify and decompose nitro compounds.

† Guttmann: Zeitschr. f. Angew. Chem., 1897, p. 233.

‡ Guttmann: Zeitschr. f. Angew. Chem., 1897, p. 265, found that it required 8½ minutes to heat ground cordite from 12 deg. to 69½ deg. C.

§ Cullen: Jour. Soc. Chem. Ind., 1901, p. 8.

‖ Guttmann, in "Ch. Tech. Untersuchungsmethoden" Lunge, II. p. 492, says zinc iodide test paper is about one-third more sensitive than potassium iodide paper.

¶ Zeitschr. f. Angew. Chem., 1897, p. 233. Jour. Soc. Chem. Ind., 1897, p. 283.

** Zeitschr. f. Angew Ch m., 1898, p. 1027.

†† Jour. Soc. Ch. Ind., May 31, 1902.

‡‡ Rivista, August, 1899.

§§ Jour. Soc. Ch. Ind., 1901, p. 10.

‖‖ Dingler Polyt. Jour. 234, p. 43.

¶¶ Zeitschr. f. Angew. Chem., 1899, p. 705

OLDEST TECHNICAL HIGH SCHOOL IN THE WORLD.

THE famous mining academy of Freiberg, Saxony, is claimed to be the oldest technical high school on earth, having been founded in the year 1766. Some interesting facts in regard to its development are given by Stahl und Eisen, based on an address by Prof. Ledebur. It appears that the earliest lectures at this institution had for their subjects metallurgical chemistry, embracing some of the metallurgical arts, and delivered by Gellert; also mathematics, mechanical sciences, and mining. Although there was a mineral collection the science of mineralogy in a proper sense was not studied, and geology was for the most part yet to arise. Mineralogy was then in its childhood and a substantial ground for the science was not attained until, in 1775, A. G. Werner was called to Freiberg and taught the employment of common sense in the determination of the minerals according to their characteristics. In 1780 Werner began lecturing on the branch of science which later he named geognosy, the present geology; so the Freiberg Mining Academy may be called the birthplace of this science. One of Werner's pupils was Alexander von Humboldt. Among Werner's successors as teachers of mineralogy were Mosz, Naumann, Breithaupt, and Albin Weisbach. It is not possible here to outline, even, the influences that in the 137 years of its existence have gone forth from this academy into the world of science. It may, however, be remarked that an instructor at the school from 1833 to 1871 was Julius Weisbach, who was a pathfinder in the fields of surveying and mechanics.

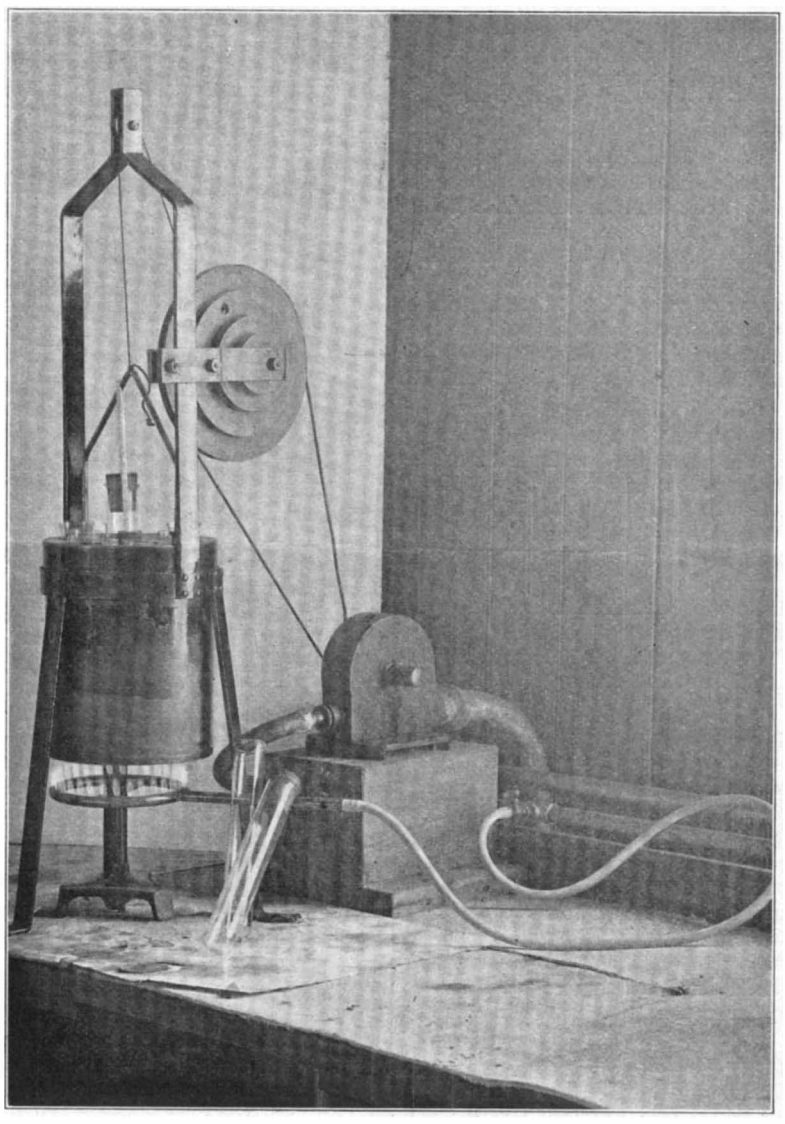


FIG. 2.—APPARATUS FOR EXPLOSION TEST.

THE CELEBRATED THUNDER MOUNTAIN REGION IN IDAHO.

SINCE the time when the Caswell brothers made their first important discovery of gold on Thunder Mountain the eyes of the mining world have been centered upon this region.

Previous to that time little or nothing was known of the country beyond the confines of the camp, an area not more than five or six miles square, and the district soon proved too small for the ever-increasing rush of prospectors eager to try their luck. Unbaffled by the ice and snow of the intricate ranges and lofty peaks surrounding this new Eldorado, the men pushed on, and finding other inviting fields enlarged upon the district in such a manner that to-day nearly all of central Idaho is included in its known mineral belt.

Among the new districts that have attracted considerable attention, I will mention the following sections: Rainbow, Monumental Creek, Big Creek, Logan Creek, Government Creek, Smith Creek, Beaver Creek, Indian Creek, Yellow Pine Basin, Profile, and Marshall Lake.

Much has already been said and written about Thunder Mountain with its lodes of gold-bearing ore so wide as to astonish all who see them. Proof has been furnished in many cases of the existence of large bodies of ore rich in the yellow metal traversing the country rock for miles.

All data obtainable in regard to the manner of occurrence of the lavas appear to indicate the presence of a volcanic center or neck in the near vicinity of Thunder Mountain.

The most noted mine in this section is the original Caswell property, now generally known as the "Dewey." The claims were staked upon a well-defined outcrop of phonolite, flanked by a confused mixture of rhyolite, tuff, and breccia. The dike itself is gold-bearing, and the mineralization extends far into the country rock, giving rise to one of those large ore bodies for which the district is famous.

The climate of the country tributary to Thunder Mountain, as would be expected from the elevation, is rigorous and the snowfall considerable. The trails that cross the ridges are often blocked by drifts of snow as late as June. October is usually the beginning of the stormy season, but the intervening summer period is characterized by almost ideal weather.

Timber is found everywhere. In some tracts it forms forests whose trees are from 14 to 36 inches in diameter. The timber of extensive tracts, however, is small but suitable for all mining purposes. Spruce and fir are found along the stream bottoms and on moist and northern exposures.

The drainage is all through Salmon River. At the lower elevations the climate is very moderate and permits the cultivation of all deciduous fruits and vegetables. In the higher altitudes the small areas of bottom lands along the watercourses are only productive of grasses. The arable land of the upper region is limited and has no agricultural possibilities.

So far the only settlement maintaining a post office is at Roosevelt. This place has a regular three-times-a-week mail service that has been carried on with little interruption.

The regular outfitting points for prospectors are at Boise and Weiser, where supplies and horses may be purchased at reasonable prices. The nearest trading stations are found at Salmon City, Warren, and Meadows.

A short time ago the only wagon road reaching the outskirts of Thunder Mountain country led from Coun-

cil by way of Payette Lake to Warren. During the excitement attending the Caswell discovery, sufficient money was subscribed by business men of Boise to construct a wagon road from the capital city to Pine Basin. The road has been extended.

Indications are that the activity of this region is but the beginning of a better day than Idaho has ever seen. The needs of a market for the products of her fields and gardens have already been keenly felt, and under the stimulus of an ever-increasing demand for bread and meat, there will spring up thousands of prosperous and happy homes on the arid desert wastes where now flourish the sage brush and a few scanty herbs only.—Mines and Minerals.

ENGINEERING NOTES.

The total horse power capacity of the steam engines and waterwheels reported by the central electric stations, as used for the operation of the dynamos to generate electric current, is 1,772,813. Of this amount, 1,379,941 horse power, or 77.8 per cent, is the indicated capacity of steam engines, and 392,872 horse power, or 22.2 per cent, the stated capacity of waterwheels. The indicated capacity of steam engines and waterwheels in the stations operated under private ownership is 1,614,577 horse power, or 91.1 per cent of the total, and of those in stations operated under municipal control, 158,236 horse power, or 8.9 per cent.

To prevent blow-holes in cast steel, M. Meslans, of Paris, adds fluid steel to an alloy of aluminium with a metal of the alkali earth group, or with lithium. Aluminium alone does not act upon the nitrogen and and hydrogen in the fluid metal. The metals of the alkaline earths and lithium possess that property, but they are too dear for use alone. An alloy of aluminium and calcium gives the effect of each element, so that carbon monoxide and also nitrogen and hydrogen can be removed.

A comparison between the heating properties of acetylene and coal gas shows that the heat units developed per cubic foot are 1850 and 630 respectively, the temperature of the acetylene flame being about 2,600 deg. Fah. With an acetylene burner consuming 2 cubic feet per hour one quart of water was brought from a temperature of about 50 deg. Fah. to the boiling point in 8½ minutes. Under similar conditions, it required 10¼ minutes for the illuminating gas to accomplish the same result, though the burner used 16 cubic feet per hour.

The utilization of acetylene gas in the blowpipe is an accomplished fact, and according to an article by M. André Binét in Le Genie Civil, has many advantageous features. Of these not the least is the very high temperatures which can be obtained. The heat is not absolutely known, but is in the neighborhood of 4,000 deg., and in any event much higher than the oxyhydrogen blowpipe is capable of. Oxygen is used in connection with acetylene, and being of higher calorific power than hydrogen, accounts for the increase of temperature.

A board of naval officers has submitted a report to the Navy Department, recommending the introduction of steam turbine engines for naval purposes. This board has witnessed tests of turbine engines on a new yacht, and reached the conclusion that, while the steam consumption ran more than eighteen pounds per horse power, the high speed given the turbine motors, and the small space required for them, the freedom of the vessel from vibration, and the small danger of breakdown made turbines worthy of trial on naval vessels. It is believed that the Navy Department will endeavor to secure an appropriation for putting turbine motors in some torpedo boats.

A scheme of startling magnitude, to remove the State capital from Cheyenne, Wyo., and locate it in a new town to be built in Eastern Fremont County, near the Sweetwater River, has been brought to light, and by publicity probably killed. The chief mover behind the enterprise is Willis George Emerson, and it is said for more than a year carefully prepared plans have been formulated. The last legislature passed a bill providing that at the next general election, which occurs in 1904, the question of the permanent location of the State capitol, insane asylum, penitentiary, hospital and other institutions shall be submitted to a vote of the people. The plan of Mr. Emerson, and unlimited capital behind him, was to spring a campaign a month or so before the election to have all these institutions located in the new city of "Emerson," which he proposed to build at the place described above. Depending on the sale of town lots to remunerate, he proposed to build structures of magnificent proportions for each institution absolutely free of cost to the State, to guarantee the building of a railroad line to the new capital, which ultimately would become a transcontinental carrier, and to carry on the development of that section of the State on an enormous scale. Lacking newspaper support, the plan was to flood the State with able orators, who would dazzle the voters with glowing accounts of the intentions of the syndicate and golden promises for the future. Through some miscarriage the plans of the syndicate have been exposed, and there is not much probability that the scheme can be consummated with all the newspapers of Southern Wyoming fighting it. So gigantic is Emerson's scheme, that the outsiders who first discovered it thought themselves confronted by a tremendous hoax, but developments have proved it a *bona fide* proposition to those connected with it.—Denver News.

ELECTRICAL NOTES.

Three-fourths of all central electric stations in the United States are located in places of less than 5,000 inhabitants. The proportion of municipal stations in such places is larger than that of stations operated under private ownership. The small towns in the North Central States appear to be exceptional in this respect. Of the 515 stations in Illinois and Iowa, 428, or 83.1 per cent, are located in places of less than 5,000 population; in Ohio and Indiana 284, or 68.8 per cent, are so located. Only 30 stations are located in the six cities having a population of more than 500,000, but these stations represent a comparatively large proportion of the industry.

During the year 1902 there were 252 electric railway companies that reported the generation of electric current for sale for light and power. Of the railway companies referred to, 118 reported to the Census Bureau that the generation of electric current for this purpose was of sufficient importance to enable them to give the number of lamps in use and the amount of income from the sale of current. Adding these stations to the central stations enumerated in the report, the number would be increased to 3,738, the total income for the sale of current to 90,458,420, the number of arc lamps to 419,561, and of incandescent lamps to 19,636,729.

In addition to the 8,388 storage battery cells in American substations, with a capacity of 25,284 horse power, there are 6,881 cells, with a capacity of 16,355 horse power, reported for the main power plants, making the number of cells for all classes of storage batteries 15,269, with a capacity of 41,639 horse power. It will, of course, be understood that the capacity of the storage batteries cannot be taken in definite horse power, that depending so much on the rate of discharge. In addition to the 2,525 transformers in substations, with an indicated capacity of 420,667 horse power, there are 207,151 on consumers' circuits, with a total capacity of 922,774 horse power, making an aggregate of 209,676 transformers, with a capacity of 1,343,441 horse power.

The development of the electrical industry in the United States is strikingly set forth in a recently issued census bulletin. It appears that in 1902 there were in operation 3,520 central station electric plants for power and lighting, representing in construction an equipment and investment of $504,740,352, and showing gross earnings of $485,700,352 per annum. The power plant equipment consisted of 5,930 steam engines of 1,379,941 indicated horse power, and 1,390 waterwheels of 438,732 horse power, driving 12,484 dynamos of 1,624,980 horse power. The electrical central station is a very new industrial development, almost wholly created during the decennial period between two census enumerations. The figures for the State of New York show this very clearly. Between 1890 and 1902 the number of electrical central stations in this State increased from 139 to 356, a gain of 84 per cent; the investment in plant increased from $31,183,618 to $112,898,778, a gain of 262 per cent.; the total horse power of plants increased from 59,512 to 323,413, a gain of 443 per cent. The earnings from motor service increased from $192,754 in 1900 to $2,396,046, a gain of 1,143 per cent. In view of the tendency now in progress to substitute electricity for steam power in the case of large numbers of individual power plants within the distribution areas of central stations, the gain of the next ten years is likely to be much greater than that of the past ten years in comparative totals if not in percentages.

The output of an electric station is determined by the kilowatt-hour output or the horsepower-hour of its current. Each American station was required to report to the Census Bureau its kilowatt-hour average per day and the total for the year, and also the horse power of the current average per day and the total for the year. In the majority of the stations no record is kept of the output of current, and the amounts reported are largely estimates based on the voltage and amperage of the machines with reference to the hours of operation. The average kilowatt-hour output of current per day for all stations is 6,814,074, and the total for the year 2,453,502,652. The horsepower-hours of current, average per day, is 9,097,796, and the total for the year 3,270,162,309. The stations operated under private ownership report 92 per cent, and those under municipal control only 8 per cent of the total kilowatt and horsepower-hours of current. According to previous tables published by the Census Bureau, the total dynamo capacity of central stations is 1,624,980 horse power, or, roughly, about 1,200,000 kilowatts. As the average kilowatt-hour output of current per day is shown to be 6,814,074, it appears from this that the electric light stations are on a basis of average daily operation for six hours, or, approximately, 25 per cent of their possible capacity of production of current. As the gross earnings from operation are slightly over $84,000,000, and the total production of current for the year is 2,453,502,652 kilowatt-hours, it appears that the earnings per kilowatt-hour are not quite 4 cents. On the other hand, it is not to be understood that the central stations are able to sell all the current that they produce, as the inevitable losses between the switchboard and the consumers' lamps and motors reduce the apparent earning capacity very seriously. But even if only half the current reported as produced were consumed and paid for and the other half were lost, the yield per kilowatt-hour would appear to be not in excess of from 7½ to 8 cents.

TRADE NOTES AND RECIPES.

According to the Parfumeur, of Berlin, the liquid tooth preparation "Sozodont" is said to contain: Soap powder 60 parts, glycerine 60 parts, alcohol 360 parts, water 220 parts, oils of peppermint, of anise seed, of clover, and of cinnamon 1 part each, oil of wintergreen 1-200 part.

Cement for Metals.—

Litharge	2 parts
Boiled linseed oil	2 parts
White lead	1 part
Copal	1 part

Heat together until of a uniform consistence and apply warm.—Spatula.

Coffee Liqueur.—Grind 500 grammes of roasted coffee, extract with 3,600 grammes of spirit of wine and 3,000 grammes of water for a week, shaking from time to time. Next filter, and add 200 grammes of cognac and 20 grammes of nitric ether. Besides boil a syrup from 2,800 grammes of sugar and 3,000 grammes of water, and while still boiling mix with the extract.—Pharmaceutische Zeitung.

Silvering Powder for Metals.—Copper, brass, and some other metals may be silvered by rubbing well with the following powder: Potassium cyanide, 12; silver nitrate, 6; calcium carbonate, 30. Mix and keep in a well-closed bottle. It must be applied with hard rubbing, the bright surface being afterward rinsed with water, dried, and polished. Great care must be exercised in the use of the powder on account of its poisonous nature. It should not be allowed to come in contact with the hands.—Annales de Pharm.

Cement for Pestle Handles.—1. Melt sufficient black resin, and incorporate thoroughly with it one-fifth its weight of very fine silver sand. Make the pestle hot, pour in a little of the mixture, then force the handle well home, and set aside for a day before using.

2. Make a smooth, moderately soft paste with litharge and glycerin; fill the hole in the pestle with the cement, and firmly press the handle in place, keeping it under pressure for three or four days.—Midland Druggist.

To Make Holes in Thin Glass Panes.—To produce holes in panes of thin or weak glass, provide the places to be perforated with a ring of moist loam, whose center leaves free a portion of glass exactly the size of the desired hole. Now pour molten lead into the ring. The glass and lead will fall through at once. This process is based upon the rapid heating of the glass, whereby the latter acquires a round crack where the heat is applied.—Neueste Erfindungen und Erfahrungen.

Lubricants for Wooden Cogwheels.—An excellent lubricating agent for wooden cogwheels consists of tallow 30 parts (by weight), palm oil 20 parts, fish oil 10 parts, and graphite 20 parts. The fats are melted at moderate heat, and the finely-powdered and washed graphite mixed with them in an intimate manner by long-continued stirring. The teeth of wooden combs are kept in a perfectly serviceable condition for a much longer time if to the ordinary tallow or graphite grease one-tenth part of their weight of powdered glass is added.—Technische Rundschau.

China Cement.—

Gum ammoniac	3 drachms
Brazilian isinglass	3 ounces
Distilled water	6 ounces
Wood alcohol	12 ounces

Add four ounces wood alcohol to the water, in which dissolve the isinglass by the aid of gentle heat; dissolve the gum in the remainder of the wood alcohol and add to the previous solution. If perfume is desired, a few drops of oil of sassafras dissolved in the alcohol can be added.—Spatula.

Renovating a Camera—The following formula should be applied to the mahogany of the camera by means of a soft rag, rubbing it well in, finally polishing lightly with a clean soft cloth:

Raw linseed oil	6 ounces.
White wine vinegar	3 ounces.
Methylated spirit	3 ounces.
Butter of antimony	½ ounce.

Mix the oil with the vinegar by degrees, shaking well to prevent separation after each addition, then add the spirit and antimony, and mix thoroughly. Shake before using.—Spatula.

Eau de Botot.—Lindel gives in the Pharmaceutische Zeitung the following receipt, which he states is an original recipe from Paris:

Anise seed	80
Clover	20
Cinnamon cassia	20
Cochineal	5
Refined spirit	800
Rose water	200

Digest for 8 days and add:

Tincture of ambergris	1
Peppermint oil	10

Atomizer Liquid for Sick-Rooms.—

Eucalyptol	10
Thyme oil	5
Lemon oil	5
Lavender oil	5
Spirit, 90 per cent	110

To half a liter of water a teaspoonful for evaporation.—Les Nouveaux Remèdes.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Hosiery for the Orient.—There was recently organized in the city of Chemnitz an exporting house having for its object the importation of cheap American hosiery into Germany and the exportation of the same to the Orient. The *modus operandi* of this new organization seems to be to bring the cheap American hose upon the Chemnitz market, where every year the great eastern buyers of hosiery congregate in large numbers, and thus introduce them more effectively into the East by putting them in direct competition with the German hose manufactured in this vicinity. It is a well-known fact that the cheaper grades of American hosiery have already demonstrated their competitive ability upon the South American as well as upon the eastern markets, but it would seem that with the aid of the new local American exporting house entering right into the heart of one of its most formidable competitors these distant markets ought to prove far more remunerative than they have in the past.

There can be no question that the German hosiery industry can hold its own against that of any other country as far as the higher grades of hose are concerned, for Germany enjoys the numerous advantages accruing from cheapness of labor, thorough technical education, centuries of successful experience, and highly developed textile machinery. But in case of the cheaper grades of hosiery, where the determining elements of competitive ability are largely those of gigantic enterprise, thorough organization, extensive production by machine instead of by hand, and the general economy effected through operation conducted upon a colossal scale, the United States has proven itself a powerful competitor.

Because of the numerous uncertainties as to the responsibility and credit of eastern firms, one of the first requisites of the exporter in dealing with this region is thorough familiarity with his prospective customers, for there are houses with unshaken credit and others which must forever be closely watched in their operations. Oriental buyers are hard business men to deal with. They possess a wide and minute knowledge of the goods they handle and are well posted as to current values.

The leading eastern houses with established reputations generally pay by check upon delivery, or by means of an "accept" payable through the German Imperial Bank of Berlin. Smaller houses often run beyond their capital and prove very slow payers. Original cash stipulations are frequently changed to a three or four months' "accept" after several months of deliberation. While Oriental buyers sometimes buy f. o. b. at the place of manufacture, they are reported to prefer, and frequently insist upon, payment upon delivery at destination. This is included in the term "cash." It is also well to remember that in Turkey and the East in general many houses include a three or two months' acceptance in the stipulation "cash." Great precaution is necessary, as experience is said to have shown the eastern buyer to be a very suspicious character when it comes to good faith that the European manufacturer or exporter has lived up to his order and his sample. He is likely to weigh the goods upon arrival and compare them with the sample submitted when the order was placed, and if he can find the slightest divergence in weight or quality, even in case of isolated dozens, he not infrequently demands reclamation out of all proportion to the discrepancy from the contract.

In the matter of the quality of the hosiery exported from Germany to the Orient, there must be emphasized the necessity of thick, heavy goods, closely knit, so as to leave little space between the threads. The reason for this is that the eastern people, using, as they do, sandals more generally than tight foot gear, require some covering that excludes insects from their feet. It will appear from this circumstance that much of the hosiery for certain Oriental countries cannot be used for other markets. In colors, black is probably most popular, according to reports here. Then, also, bright colors, such as green, light blue, pink, orange, lilac, and gay combinations, are easily disposed of in the East. The quantity bought depends largely upon the price of the goods. Hosiery ranging between 1.50 and 2 marks (35.7 and 47.6 cents) are reported to be purchased, in general, from 3,000 to 5,000 dozen pairs at a time by large houses. Those ranging in price from 2.50 to 3.20 marks (59.5 to 76.2 cents) sell in quantities from 500 to 1,000 dozen pairs; articles above 5 marks ($1.19) are at times disposed of in quantities of less than 100 dozen pairs.

In the line of underwear, medium maco shirts and drawers—sizes 34, 36 and 38 inches for shirts, and 32, 34 and 36 inches for drawers—are most easily disposed of. The heavy quality of underwear, as manufactured in southern Germany, also finds a good market. In ribbed vests the cheaper grades sell best, with some demand for the fine wool grades.

The matter of packing is a very important consideration in exporting to the Orient. Generally, goods costing more than 2.50 marks (59.5 cents) must be put up in boxes of half a dozen, and those costing less than this amount in boxes of 1 dozen. Every pair of hose must be sewed together at three places by means of a woolen thread. Why preference is given to woolen thread is not quite plain, but from information at hand I find that such is the fact. In many cases eastern houses have their own peculiar methods of packing and require the hosiery to be done up in accordance with their instructions. Great emphasis is always placed upon the stamping of the goods in general, as many as three stamps being demanded. Another common requirement is that the boxes used for different dozens and varying qualities must be made of paper of easily distinguishable colors.

Under the present freight rates the transportation of goods is not as considerable an item as might be expected at first thought. A competent local shipper gave me the following estimates on freightage from Philadelphia to Constantinople: For every 40 cubic feet of space, a charge of 16.25 marks ($3.87). This, he estimates, puts the transportation charges at about 10 pfennigs (2½ cents) per dozen hose.

There is every reason to believe that the new venture of the exportation of cheap American hosiery to the Orient by way of Germany will be successful, as a roundabout way of exportation has been used heretofore. Good authority has it that during the last year at least $75,000 worth of American hosiery found its way into the East, especially the English colonies, by way of London. It would seem that these efforts will be even more successful when the American product is brought into immediate competition with the German make by being brought directly to the notice of the eastern buyer as he makes his annual visit to the Empire.

Most of the foregoing facts were obtained in conversation with commission men of this city who are desirous of adding to their German trade that of America as well. Almost in the same manner the German exporter was driven from the South American market. If our manufacturers and exporters give proper attention to all the details, such as packing, quality, stipulations of contract, adherence to sample, promptness of delivery, etc., there can hardly be a question of doubt but what we will be able to get a big share of the eastern trade. Especially necessary is it to emphasize promptness in delivery and the most scrupulous care as to the external appearance of the goods.

The men who are interested in this new undertaking are well posted in the eastern trade and represent a number of Chemnitz houses. For this reason they do not wish to have their names made public until the undertaking is ripe. Any correspondence on this subject addressed to this consulate will gladly be handed over to the men who are back of this new enterprise.—J. F. Monaghan, Consul at Chemnitz, Germany.

New Trade Openings Abroad.—Electric Lighting.—It is suggested that Thorshavn, in the Faroe Islands, should be provided with electric lights. The water power is abundant for nine months of the year, and during that period it is so dark that artificial light is necessary. Petroleum lamps are generally used in the shops and houses and for street lighting; this could all be advantageously replaced by electric lighting during the season that lights are most needed. During the months of May, June, and July, when the streams are the lowest, no lights would be needed, as it is daylight constantly.

Gas Engines.—Low gas motors are being employed in Russia as a result of the cheapness of the anthracite from the southern coal basins. The gas of blast furnaces is also being utilized by these motors. A large number of 1,000-horsepower machines on the "Durtz" system have been imported. Naphtha, petrol, and benzine motors are also regarded as worthy of attention.

Nitrate of Soda.—A recent report from Bilbao states that there is a very strong possibility of the import trade in nitrate of soda and sulphate of ammonia for agricultural purposes being considerably increased, owing to the efforts to improve the methods of cultivation in Spain. About 4,000 tons of nitrate are used every year at Bilbao in the production of acids and chemical manure. During 1902 16,389 tons of chemical products were imported into Bilbao, as follows: From Great Britain, 6,158 tons; America, 3,228 tons; Germany, 1,807 tons; and France, 683 tons; etc.

Windmills and Agricultural Implements for Siam.—The Klong Rangsit rice district of Siam is at present a good market for windmills. The mill should be made of galvanized steel about 16 feet in diameter and suitable for furnishing power for irrigating purposes in dry weather and for husking and milling rice in wet weather and during the planting season. The dry season extends from November 1 to May 1, and during this season the soil is in such condition that agricultural implements can be used on the fields for plowing, harrowing, or even reaping.

Argentina's Meat Supply.—In Advance Sheets No. 1,602 (March 24, 1903), the Bureau of Statistics published the terms of the Argentina-Uruguay convention as to sanitary inspection of live stock, the completion of which was necessary to bring about a reopening of the British ports to Argentine stock, furnished by Minister Lord. To that convention is due perhaps the recent increase in the meat production of the Argentine Republic, as shown by the following statistics taken from the South American Journal of August 29, 1903:

"Extraordinary progress has been made in recent years in Argentina in the production and export of beef and mutton. Whereas in 1895 it was difficult to get 40,000 steers in all Argentina that were fit for the British market, the output since then has increased by 40,000 head per annum, and last year it totaled 250,000 head. Argentina's export of beef and mutton will continue to go up by leaps and bounds. It is not unreasonable to believe that by the end of the present decade Argentina will be able to export to the European market—which practically means the British market—no less than 10,000,000 hundredweight of beef and 5,000,000 hundredweight of mutton. The resources of Argentina are practically unlimited, and they have been immeasurably developed in recent years by the wholesale laying down of Argentine lands to alfalfa, a very nutritious leguminous crop, which enriches the land with nitrogen accumulated from the atmosphere, and is, through its deep-rooting habits, practically uninjured by drought. There appears to be no reason to doubt that the exports of beef and mutton from Argentina will continue steadily to increase. Indeed, it seems clear enough that between Canada, on the one hand, as an exporter of wheat, and Argentina, on the other hand, as an exporter of meat, the British farmer will before long have to face a keener and more cutting competition than ever before."

Foreign Trade of Mexico.—A *résumé* of a report of Mexico's foreign trade published in El Economista Mexicana of August 22, 1903, shows the following facts:

"The imports during the fiscal year amounted to $68,966,044.93 in gold, of which the proportion from the United States was 58 per cent., from Great Britain 13 per cent., and Germany and France 10 per cent. each. Nearly every European country lost ground, while the United States gained, and in about the same ratio that Europe lost. One reason advanced for the European decline in Mexican trade is the improved native manufacture of textiles. Local factories are now making very good woolen suitings, both for men and women, and less of these goods will be imported each year. This year a new departure has been made with a view to develop the Mexican textile trade. The government has sent a commission, consisting of two merchants and an expert from the customs department, to South America with a view to opening up trade with those countries in Mexican products.

"The United States leads in furnishing both the machinery and the raw material for this new industrial development in Mexico.

"The exports, outside of metals, amounted to $69,721,730 in gold, of which the United States took 81 per cent., while all Europe took but 15 per cent.

"The British Consul resident at Veracruz suggests to the manufacturers of Great Britain that they appoint regular agents, more travelers, and employ lists and catalogues in the Spanish language, and make the articles the people want."

American Grain Shippers at Fault.—German papers state that European purchasers of wheat and corn received from southern parts of the United States seriously complain about the bad condition of the grain when it reaches them. They claim that nearly half of all the maize coming to them from the United States is defective, and they have discussed among themselves the advisability of discarding the certificates issued by the United States inspectors. Heretofore it has been the custom of the trade to accept these certificates as proof of the sound condition of the grain, and in former years the consignments tallied with the inspectors' documentary evidence. Under the present usage the recipients of the grain, though the goods be found damaged on arrival, have no remedy at law or recovery for loss sustained, as the inspectors' certification protects the shipper.—Simon W. Hanauer, Deputy Consul-General at Frankfort, Germany.

American Goods in Quebec.—The sale of American goods is increasing in this part of Canada. Many concerns have traveling men covering the territory with good results. The sales of farming machinery and boots and shoes have been constantly gaining. The demand for American farming machinery has grown to such an extent that some American manufacturers are now building factories in Canada to make their goods here. Where bright and energetic traveling men have been employed to sell American goods, sales have generally been made even if the price of the goods was somewhat higher than similar goods of Canadian manufacture, and this is especially true of the two classes of goods above mentioned.—Paul Lang, Consul, Sherbrooke, Canada.

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Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

SELECTED FORMULÆ.

Toilet Vinegar.—

Dried rose leaves	2 ounces
Triple rose water	5 ounces
White vinegar	20 ounces

Macerate for 14 days and filter.—Drug. Circ.

Bridal Bouquet.—Sandal oil, 30 minims; rose extract, 4 fluid ounces; jasmin extract, 4 fluid ounces; orange flower extract, 16 fluid ounces; essence of vanilla, 1 fluid ounce; essence of musk, 2 fluid ounces; tincture of storax, 2 fluid ounces. (The tincture of storax is prepared with liquid storax and alcohol [90 per cent], 1:20, by macerating for seven days.)—Spatula.

Shoe Polish.—

White wax	18 parts
Spermaceti	6 parts
Spirit of turpentine	65 parts.
Asphaltum varnish	5 parts.
Powdered borax	1 part.
Lampblack	5 parts.

Melt the wax and add the borax, stirring well and heating until the mass resembles jelly. In another vessel melt the spermaceti, add the varnish previously mixed with the turpentine, stir well and add to the wax. Finally add the lampblack, previously rubbed smooth, with a little of the mass.

For ladies' shoes, liquids more varnish-like than the foregoing have long been in use. They, of course, tend to harden the leather. A formula for such a dressing follows:

Anilin black	5 parts.
Camphor	10 parts.
Shellac	120 parts.
Alcohol	365 parts.

Shellac, which is the ingredient giving luster to the dressing, may also be dissolved in an aqueous alkaline solution, according to the appended recipe:

Shellac	2 ounces.
Ammonia water	1 ounce.
Water	6 ounces.
Anilin black, sufficient to color.	

Boil all the ingredients together, except the anilin, until the shellac is dissolved; then add the anilin and sufficient water to make the liquid up to the measure of 16 ounces.

Hager gives the following formula for producing a similar result in a different way:

Gallic acid	5	grammes.
Borax	5	grammes.
Logwood extract	2.5	grammes.
Anilin black	10	grammes.
Ammonia water	10	grammes.
Hot water	50	grammes.
Aqueous shellac varnish (as below)	2,000	grammes.

The aqueous shellac varnish is prepared as follows:

Borax	100	grammes.
Water	2,250	grammes.
Powdered shellac	300	grammes.

Heat the water to the boiling point, dissolve the borax in it and then add the shellac in small portions, stirring the liquid constantly until solution is effected. When cool, strain.—Drug. Circ.

Furniture Polish.—We print below some recipes for preparations with which to repolish furniture.

I.

Shellac	4 parts.
Alcohol	32 parts.
Oil of turpentine	16 parts.
Linseed oil, boiled	32 parts.
Ammonia water	4 parts.

Dissolve the shellac in the alcohol; dissolve in a separate vessel the linseed oil in the turpentine, and mix the two solutions, adding them slowly with continuous agitation; then add the ammonia water and mix by agitation until thoroughly homogeneous.

II.

Mix one part of old boiled linseed oil with 2 parts of an alcoholic solution of shellac. Agitate each time before using, and apply in small quantities, rubbing vigorously until the polish is attained.

III.

White wax	2,500 parts.
Water	4,500 parts.
Potassium carbonate	25 parts.
Oil of turpentine	4,000 parts.

Boil the wax in 1,500 parts of the water, carrying the potassium carbonate, until the wax is emulsified. Add sufficient water to replace that lost by evaporation and stir till cold and add, little by little, under constant agitation, the oil of turpentine, and continue to stir until a complete emulsion is obtained. When this occurs add the remainder (3,000 parts) of the water all at once and stir in. In case the mixture is incomplete add a little more oil of turpentine.

To use the cream smear a little of it on a thin soft rag and with this go over the furniture; then polish with a woolen cloth, or bit of flannel. The cream answers equally well for leather upholstering, imitation leather, leather, cloth, marble, etc.

IV.

Paraffin wax	7 ounces
Petroleum jelly	2 ounces
Solution of potassa	5 drachms
Yellow wax	3 ounces
Oil of turpentine	12 ounces

Place the first four ingredients in a vessel and melt with gentle heat; allow the mixture to cool and then add the turpentine, stirring well together.—Drug.

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