Stegosaurus ungulatus. The entire length of this dinosaur was thirty feet or more. The stegosaurus, instead of being entirely defenseless like the immense brontosaur described above, was provided not only with a complete osseous dermal covering, but with a series of large, erect, bony plates, protected by a thick, horny covering, extending along the back and part of the tail, and further to the end of the tail by four pairs of spines of great size and power.

We are, in this animal, confronted with a strange reversal of the first and governing principle of construction common to all modern vertebrates. An enlargement of the spinal cord in the pelvic region, giving a reinforcement of nervous power to the generally disproportionately large hinder half of dinosaurs, is in a number of species quite apparent, but in the stegosaurs the development of the lumbar region takes complete precedence of the fore part of the animal. The head—so diminutive in proportion to the entire bulk of this colossal reptile that it becomes a problem how a sufficient amount of food to sustain and nourish the enormous body could have passed through the jaws—contained a brain which, taking the proportional size of the two creatures into consideration, was one hundred times smaller than that of an alligator; but, as is well known, a second brain, twenty times greater than that contained in the skull, found place in the sacral cavity, and governed and intelligently directed the movements of the hind limbs and the armed tail of the monster.

## THE NEW STREET RAILWAY TUNNEL UNDER BOSTON HARBOR.

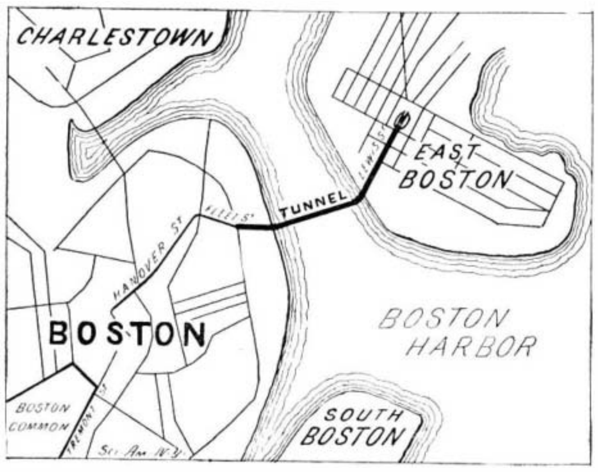
BY J. A. STEWART.

Street railway expansion has been going on rapidly in Boston by underground, elevated, and surface lines. Its latest and most interesting development is the new tunnel under the harbor from the South Ferry, on Atlantic Avenue, to the peninsular district known as East Boston.

When the Boston subway was built a few years ago, it was suggested that it would prove but the beginning of a network of subterranean avenues which would underlie the entire city—a statement which recent movements seem to have justified.

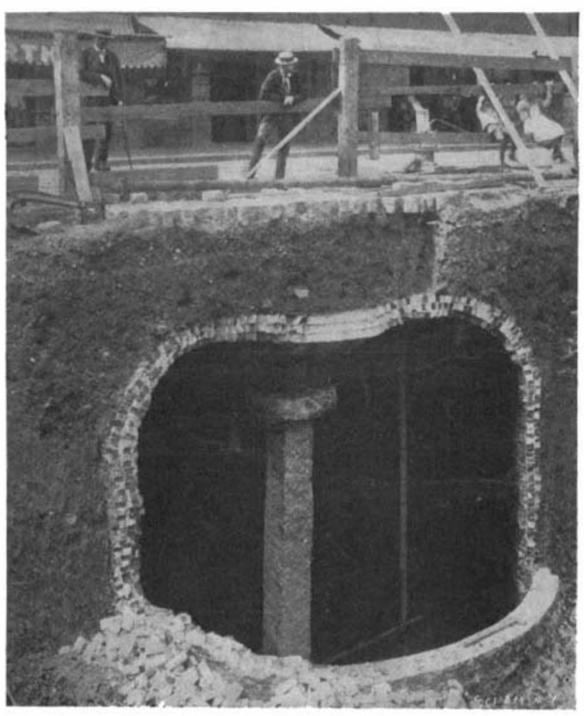
The legislative act of 1894, which authorized the people of Boston to appoint a Transit Commission to construct a subway under Boylston, Tremont and various streets in the north part of the city to the Union Station, also empowered that body to build the tunnel under the harbor to East Boston.

Work on the construction was begun May 5, 1900. The portion of the work then commenced—in Maverick Square and Lewis Street, East Boston—was not difficult of construction. The engineering problems, as the work could be in open cut, were of an ordinary nature. The excavating for the incline in Maverick Square was done without timbering the trench, and the earth was shoveled into carts. The sidewalls of the incline are of concrete, faced with granite and surmounted by a granite coping. Granite also surrounds the portal. The subway or covered portion of this section is a concrete monolith. Nuts and washers are embedded in the masonry to admit of the use of steel tie-rods for increasing the strength of the roof, if deemed desirable. The grade is 5 per cent, and the bottom of the masonry invert is about 39 feet below the surface of the street.

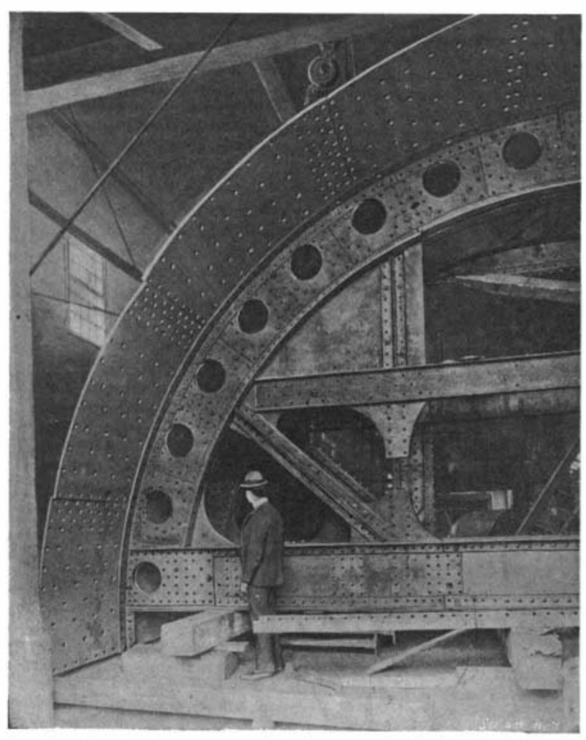



MAP OF BOSTON, SHOWING LOCATION OF TUNNEL.

In preparing to put in place the masonry for the covered portion, the bottom of the excavation was graded, and three thicknesses of tarred felt were laid. They were thoroughly pitched together, and when the pitch had hardened, the concrete invert was put in and 6-inch back walls were carried up a convenient distance, the sheeting being removed and the trench rebraced as was necessary. The back walls were plastered with a rich Portland cement plaster, and against this the main wall was built. Wooden centers were used, and work on each section of the concrete arch was carried on continuously until its completion. Beginning in Maverick Square, the East Boston tunnel runs under Lewis Street, Boston Harbor, and, on the Boston side, under Eastern Avenue, Fleet and Hanover Streets, to Friend Street, where it connects with the subway system. The tunnel proper lies between the two South Ferry slips, a distance of about 2,250 feet.



OLD RESERVOIR, UNEARTHED IN MAVERICK SQUARE.



A QUARTER SECTION OF THE EXCAVATING SHIELD.

In considering the important question of construction, the Commission was greatly aided by the experience of foreign cities as personally investigated by Chief Engineer Carson. Cast-iron twin tubes, of 10 to 12 feet in diameter, are used in the Glasgow street railway tunnels and in the London Underground Road, which passes under the Thames. Comparing the relative merits of twin tubes or a single wider tube, the Commission came to the conclusion that, although a wide tube would be more costly and would have less favorable grades than twin narrow ones, the wide tunnel would conduce more to the comfort of passengers, would be much more satisfactory to the public, and would be more in accordance with the work previously done by the city.

The Boston Harbor tunnel is an arched structure for two electric railway tracks. The thickness of the roof of earth over the outside of the arch of the tunnel under the harbor is from 16 to 18 feet. Above this, in the deepest part of the harbor, is 35½ feet of water at mean low tide. The tunnel under the harbor is about 20½ feet high inside; about 23 feet wide, and about 2,250 feet long. Its walls are 33 inches thick at minimum measurement.

The tunnel, on the East Boston side, has grades from 4.7 to 5 per cent. At a point 250 feet southwesterly from the Harbor Commissioners' line it is about 100 feet lower than in Maverick Square. A length of about 1,350 feet in mid harbor is nearly level. Short-length grades of 5 per cent occur on the Boston side, caused by the intervention of Commercial Street, where the east-bound platform is immediately below that for the west-bound cars, their depths below the street being respectively 66½ and 50 feet. There are pumpwells and chambers under the harbor.

In constructing the tunnel the shaft in Lewis Street was sunk to grade, and sidewalls were commenced in small tunnel drifts. A steel roof-shield spans these sidewalls and is pushed forward on them by means of hydraulic jacks. As the roof-shield is advanced step by step the arch is put in place inside. An air lock is built at a distance of 100 feet within the tunnel, by means of which air may be compressed to the degree necessary to prevent any objectionable flow of water into the working portion of the tunnel. A most interesting and important feature of the tunnel is its arrangement as to ventilation. In respect to good air, it is well known that the Boston underground system cannot be rivaled by any of its contemporaries. The City and South London Railway, 3½ miles long, consists of two cast iron tubes about 11 feet in diameter.

APPROACH TO THE BOSTON TUNNEL, MAVERICK SQUARE.

THE MONOLITHIC, CONCRETE, ROOF OF THE TUNNEL.

Through these tunnels, at an average depth of 50 feet, the cylindrical cars are run by electricity. Each small car pushes, piston-like, a column of air before it, the vacuum being supplied by fresh air from the rear. If it was not necessary to close the cars on account of the draught the arrangement would be completely satisfactory. But by reason of their small size the air within soon becomes impure though that in the tunnel is good.

The tunnel under the Mersey has two stations 80 feet underground and about a mile apart. Near each of these stations there are ventilating fans, which draw the vitiated air from the tunnel, fresh air to supply the requirement passing in through the stations. The tunnel, however, is traversed by steam cars, which render almost any system of ventilation practically ineffective.

In addition to the absence of steam and smoke the East Boston Tunnel has all the advantages of a scientific ventilation. Ventilating chambers are constructed on each side of the harbor. Ventilation is effected by a segmental duct of about 45 square feet area in the top of the tunnel. Near the middle of the harbor this duct communicates with the tunnel underneath by a door. The shore ends of the duct open into the ventilating chambers through which the air can be drawn out. The air enters from the open end of the tunnel in Maverick Square, and at or near the Commercial Street station it passes through the main body of the tunnel, enters the door in the duct, and returning to the shores is drawn out through the ventilating chambers.

The estimates place the cost of construction to the city at about $2,700,000. The work is in charge of Chief Engineer Howard A. Carson, who has already rendered the city excellent service as superintendent of its main drainage system, as engineer of the sewer systems of the Charles and Mystic Valleys, and in the Boston Subway work.

### An Electric Lighting Board.

An ingenious system of electric lighting, called the "electric lighting board," has been recently patented by a company in London, by means of which it is possible to obtain a wide range of curious and novel lighting effects, quickly and cheaply, without involving the employment of any special appurtenances or necessitating any wiring. The lights may be also placed at any points, and can be removed to other portions of the board as frequently as may be desired without the slightest delay, and with the certainty that they will light up. The board to carry the lamps is covered with a face of cork and rubber. Beneath this substance is fixed a number of wires in a warp and embedded in asbestos. The lamp utilized is of the ordinary incandescent type, differing only in the fact that a specially milled shoulder is attached to cap and plug, from which project two sharp pins. To place the lamp in position it is only necessary to press these pins into the permeable coating of the board, and directly the pins touch the wires beneath the circuit is completed, and the lamp lights up. No fixing of the lamps in sockets is required, because a sufficiently strong hold can be effected by pressing the lamp into the rubber and cork. The numerous advantages accruing from this system will be readily recognized, since it dispenses with the employment of lamp holders, sockets, fixing, tapping, and so forth. Consequently the cost of material is greatly reduced, and no technical knowledge or skill is necessary in fixing the lamps. The presence of asbestos obviates all danger from combustion, which is liable by the formation of the arc caused through breaking the electrical circuit by displacing the lamps. It is also impossible, owing to the system of wiring adopted, to cause a short circuit. The electrical resistance is high. The purposes for which this system can be adapted are innumerable, especially in those installations where great illumination is desired, or the transpositions of the lights. On such a board words may be displayed in electric light and altered whenever desired. The system can also be used for filletings, mouldings, or other decorative purposes. It also lends itself to scenic effects upon the stage or for temporary lighting. The company have also completed experiments by which a narrow electric lighting flexible strip of any length is available for decorative or other purpose.

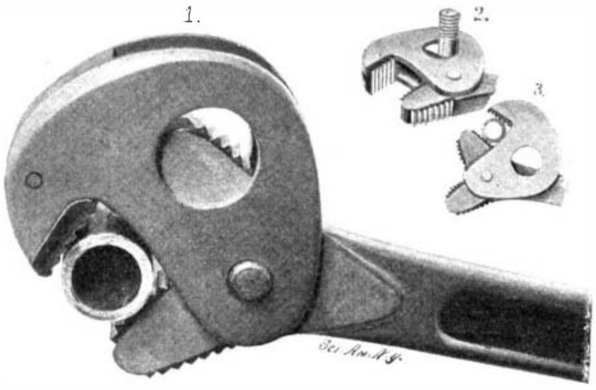
The American Geographical Society will move into its new building in 81st Street, New York, some time in May or June. The new structure is a very handsome one. There is no special assembly room, and the numerous lectures will be given in outside halls, as usual. A room capable of holding 300 persons has, however, been provided. The principal rooms are the reading room, the library and the parlors. The expenses for the new building are being paid out of a fund of $100,000 donated by Gen. Cullum and other contributors. The society has about 1,200 members. It was founded in 1852.

### A NOVEL PIPE AND STUD WRENCH.

A recently-patented pipe and stud wrench invented by M. Z. Viau, of Malone, N. Y., is characterized by a novel construction which enables the jaws to grip a pipe or stud in various positions and to adapt themselves to pipes widely different in size.

As shown in our illustrations the end of the wrench-handle is formed with two toothed arms, between which a toothed movable jaw is pivoted, having an opening for the reception of a ⅝-inch stud.

The arrangement of parts is such that the movable jaw can be made to assume four positions relatively to the toothed arms and that a pipe can be gripped in any one of six positions of the movable jaw without reversing the jaw. The wrench automatically adjusts itself to the size of the pipe or stud. But one hand is necessary to operate the wrench, since by passing the pipe through the opening in the movable jaw the pipe



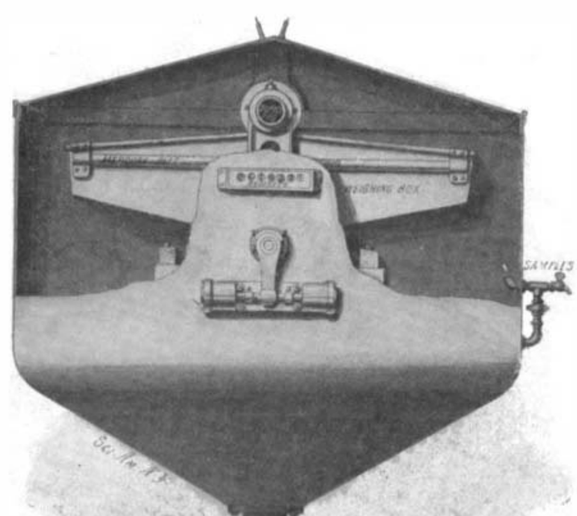

THE VIAU PIPE AND STUD WRENCH.

may be gripped simply by turning the wrench to one side or the other. Owing to the shape of the working face of the movable jaw the wrench can readily engage a pipe laid flat against a wall or floor.

### AN AUTOMATIC WEIGHING-MACHINE FOR LIQUIDS.

In sugar making, before the losses in manufacture can be determined, the weight of the raw sugar must be known. A perfectly trustworthy and satisfactory method of weighing the sugar present in the cane would be of immense value in determining the losses in clarification, filtration and concentration, in boiling to grain and in curing, and in waste molasses. With losses ascertained, the undetermined loss in the raw sugar can be easily computed. And thus the sugar manufacturer can exactly determine what his loss may be and how it may be reduced to a minimum.

To measure these losses by volume is a method which is difficult and almost impracticable. For that reason Mr. Christian J. Hedeman, a Hawaiian inventor connected with the Honolulu Iron Works, has resorted to the simpler and more efficient method of weighing



THE HEDEMAN SUGAR-JUICE WEIGHING-MACHINE.

the raw juice, sirup or molasses. His machine has proved of such service on sugar plantations of the Hawaiian Islands, that it will be introduced into the United States by the Krajewski-Pesant Company, of 32 Broadway, New York city.

Mr. Hedeman's machine comprises a tilting tray divided into two compartments into which the juice to be weighed flows from a supply-pipe. Each compartment has an outlet which discharges into the casing or receptacle by which the device is inclosed. Extending longitudinally through the tray is a pipe partially filled with mercury, which serves as shifting weight to weigh off the juice and balance the tray. Two air-cylinders are located at opposite sides of the fulcrum of the tray; and in these cylinders are pistons connected by a stem actuated by the tray-trunnions.

The liquid runs into the compartment of the tray which happens to be uppermost. When the weight of the liquid is balanced by the mercury in the pipe, the tray is tilted by the additional liquid which flows into the compartment. So sensitive is the device that a very small additional amount of liquid suffices to tilt the tray. The filled compartment, then lowermost, discharges its contents, and the other compartment, now uppermost, is filled. The air-cylinders described prevent the tray from coming to rest with a heavy shock and do not operate until the partition between the compartments has passed the stream of liquid. Thus an error, due to friction, produced by pressure in the air cushions is avoided.

An automatic cut-off can be employed to make the machine even more accurate. And a register can be used to record the amount weighed. The machine can be very simply cleaned and adjusted and can be utilized in refineries, breweries, tanneries or distilleries for weighing liquid ranging in thickness from molasses to water.

### Electrolytic Sugar.

M. Dupont made known to the Congress of Chemistry, which assembled on the occasion of the Exposition, says La Nature, the results of his researches upon the extraction of different sugars by electrolysis. The electrolyzer consists of a wooden trough divided into three compartments by porous partitions made of parchment paper or porcelain or asbestos. The electrodes consist of metallic plates that vary according to the object to be attained (platinum, aluminium, lead, zinc, etc.). A current of 15 volts, and of a density of from 25 to 30 amperes per square meter of anode is employed.

In order to obtain sugar from cane or beets, the saccharine juice is placed in the central compartment, and the end compartments are filled with water. Under the influence of the current, the albuminoid substances of the juice coagulate and precipitate, and the salts are decomposed. The juice becomes clear, limpid and colorless, and no longer contains anything but sugar and a few traces of organic matter plus a little lime and magnesia. By the term "sugar" is to be understood all kinds of sugar. There is no osmosis through the partitions. In the end compartments accumulate the soda, potassa and ammonia.

It is possible that the process studied by M. Dupont may be applicable industrially. The future will inform us as to that. But, however that may be, it is already very advantageous as a means of analysis. It permits, in fact, of rapidly searching for, isolating and making a quantitative analysis of the various sugars that may exist in a large number of plants.

A scientific party sent out by the United States Geological survey will travel by dog sledge over Alaskan ice bound for the Koyukuk River, 700 miles long and one of the two largest northern tributaries of the Yukon. Some miners in 1898 found pay dirt up this river on the gold belt that runs through Alaska. A large camp is there now, and the miners are doing well. Some distance below the mining camp the Altenkakat tributary joins the Koyukuk, and here a large supply of provisions was cachéd last summer for the use of the exploring party that is just starting out on its journey. This party is to travel from the mouth of the Altenkakat to the shores of the Arctic Ocean. It is a virgin field for explorers. The main purpose is to look for new gold fields, which, it is believed, may exist in the unknown region. The geology of the country will also be studied and geographic features delineated. The results are likely to be very interesting and valuable. D. J. Peters, of the Geological Survey, who will be the leader, left Washington last week for Seattle, whence he and his seven assistants will sail for Alaska.

### The Current Supplement.

The current SUPPLEMENT, No. 1316, opens with an article on "Automatic, Changeable Electric Signs," giving details of the Mason Monograms. "American Engineering Progress.—I—Present Conditions," is referred to elsewhere in this issue. "The Education of the Shipbuilder" is a paper by J. H. Biles. "The Manufacture of Starch from Potatoes and Cassava" is accompanied by a number of engravings. "Some Animals Exterminated During the Nineteenth Century" is an interesting article. "The Naval War Game" describes this very curious game. The usual "Trade Suggestions from United States Consuls" and "Trade Notes and Receipts" are published.

### Contents.

(Illustrated articles are marked with an asterisk.)